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THE EFFECTIVENESS OF PROGRAMMED "GRAFDRILS" IN TEACHING THE ARABIC WRITING SYSTEM.

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DESCRIPTORS- *ARABIC, *WRITING, TEACHING TECHNIQUES, PROGRAMED MATERIALS, GRAPHEMES, HANDWRITING INSTRUCTION, ORTHOGRAPHIC SYMBOLS, TAPE RECORDINGS, LANGUAGE RESEARCH, AUTOINSTRUCTIONAL PROGRAMS, GRAFDRILS, MODERN LANGUAGE APTITUDE TEST,

THIS IS A FINAL REPORT OF RESEARCH IN THE TEACHING OF THE ARABIC WRITING SYSTEM, CONDUCTED IN THE HARVARD SUMMER SCHOOL IN 1962. A CONTROL GROUP WAS TAUGHT ARABIC IN THE TRADITIONAL GRAMMAR-TRANSLATION METHOD, FOR APPROXIMATELY 15 HOURS, WHILE THE EXPERIMENTAL GROUP USED A SET OF SELF-INSTRUCTIONAL MATERIALS ACCOMPANIED BY TAPES FOR THE SAME AMOUNT OF TIME. THESE PROGRAMED MATERIALS CALLED "GRAFDRILS" ORIGINATED IN THE PHONETIC SCRIPT TEST OF THE MODERN LANGUAGE APTITUDE TEST AND ARE ORGANIZED INTO SIX PHASES--PRESENTATION, WRITING DRILL, GRAPHIC DRILL, SOUND DRILL, WRITING PRACTICE, AND DICTATION DRILL. THE TECHNIQUE INVOLVES BASICALLY "THE SYSTEMATIC PRESENTATION OF CORRELATED VISUAL AND AUDITORY STIMULI IN SUCH A WAY THAT A SUBJECT CAN NOTE THESE CORRELATIONS AND USE THEM IN MAKING HIS RESPONSES TO PROBLEMS CALLING FOR THE MATCHING OF A SPEECH RESPONSE TO A VISUAL STIMULUS OR A WRITTEN RESPONSE TO AN AUDITORY STIMULUS." THE AUTHORS CONCLUDE FROM THE RESULTS OF THE TESTS THAT THE "GRAFDRIL" TECHNIQUE IS IN GENERAL "A MORE EFFICIENT METHOD OF TEACHING A WRITING SYSTEM THAN EITHER (A) A LECTURE-TYPE CLASSROOM PRESENTATION, OR (B) SELF-STUDY FROM A TEXTBOOK." THE APPENDICES TO THIS REPORT INCLUDE SAMPLE "GRAFDRIL" SHEETS AND TAPE-SCRIPTS, WRITING PRACTICES, INSTRUCTIONS REGARDING PREPARATION OF A CRITERION TEST, A TEST SHEET AND A TAPE SCRIPT. (AMM)

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TABLE OF CONTENTS

List of Tables

List of Figures

INTRODUCTION

For the American student of Arabic, the writing system presents what seems to be one of the more difficult hurdles to surmount before much real progress can be made with the language. Despite the fact that instructors sometimes minimize the extent of this problem, many students have testified that difficulty in rapid reading of the Arabic writing system has impeded their progress for weeks or months after starting the study of written Arabic. The problem seemed to deserve systematic study and investigation, not only for its own sake, but also for the sake of better knowledge about how new orthographies in foreign languages can be learned with optimal efficiency and least effort.

The traditional method of teaching the Arabic writing system, if it can be called a teaching method, has been for the instructor to assign students the task of studying it by themselves, using the lists of grapheme-phoneme equivalents set forth in standard textbooks and going through a sometimes painful process of attempting to decode actual Arabic texts. Although instructors often assume that requisite facility can be attained in a few days, the evidence suggests that this cannot ordinarily happen.

Recognizing this problem, Frank Rice (while he was a member of the language teaching staff of the Foreign Service Institute, Dept. of State) prepared a pamphlet to ease the way of the learner (Rice, 1952). This pamphlet, which is now available in a revised version (Rice, 1959) and for which there is now available an accompanying tape recording giving the sounds of Arabic, is undoubtedly a useful adjunct to instruction in Arabic.

Nevertheless, many students find that Rice's pamphlet and tape are not enough. Apparently they need a system of instruction which is even more rigidly controlled and "programmed."

The present experiment has sought to investigate the possible efficacy of a method of teaching called the "Grafdril" method, patterned after a testing method invented by the writer around 1954 and incorporated as Part 2, "Phonetic Script," in the Modern Language Aptitude Test (Carroll and Sapon, 1958). In its application in the MLAT, the method involves presentation of a series of correlated visual and auditory stimuli which are arranged so that the examinee can learn a number of grapheme-phoneme equivalences in the Trager-Smith phonemic transcription of English and thereby correctly match phonemically-transcribed syllables with their auditory equivalents. In effect, the examinee is taught to "read" this phonemic transcription. Since the test is very rigidly paced, there is considerable variation in the ability of individuals to learn to make the correct matchings, and scores on this subtest are a particularly good predictor of ability to learn a foreign language (Carroll, 1962). It was thought, however, that this type of exercise could be modified and adapted so that it would constitute a particularly effective teaching method, suitable for various levels of language aptitude.

This report includes a description of the manner in which the Grafdril method was adapted for use in teaching the Arabic writing system and an account of a controlled experiment to determine the efficacy of this system of teaching.

The Grafdril materials are self-instructional; that is, they require no instructor, since they are presented solely by means of a tape recording correlated with printed materials that are put in the hands of the student. The experiment described in this report shows that the Arabic Grafdril materials are clearly more efficacious than a skilled instructor of Arabic using the same amount of time (approximately 14 hours) as the self-instructional Grafdril materials.

The Grafdril method was invented and developed independently of the current "programmed instruction" movement (Lumsdaine and Glaser, 1960), although there are a number of similarities in rationale and approach.

THE GENESIS OF THE GRAFDRIL METHOD

As mentioned previously, the Grafdril* method had its origin in the so-called Phonetic Script test included in the writer's Modern Language Aptitude Test. This test was devised because it appeared that an important aspect of language aptitude was the ability to learn grapheme-phoneme correspondences. Various types of measures of what was then called "sound-symbol association ability" were devised and tried out as language aptitude predictors: some, for example, were based on foreign alphabets such as the Devanagari and the Mongolian. Interestingly enough, however, the most effective test was one measuring the examinee's ability to learn grapheme-phoneme correspondences in his native language. Exactly what kind of ability lies at the root of this performance remains unclear; the writer has speculated that the test involves

> "the ability to 'code' auditory phonetic material in such a way that this material can be recognized, identified, and remembered over something longer than a few seconds. ... This ability, it would seem, is measured chiefly by the Phonetic Script Test, in which the individual has to learn how a series of speech sounds are represented by alphabetic characters; in order to do this, however, the sounds have to be 'coded' or 'stored' long enough to be compared with other sounds, and the individual has to build up a considerable repertoire of responses" (Carroll, 1962, pp. 128-129).

The Phonetic Script Test may be described as follows: The examinee is told (through taped instructions) that he is going to learn a system of writing English sounds in which each letter corresponds to only one sound. He is told to look at sets of nonsense syllables while their auditory equivalents are read aloud on the tape. A sample unit of the test is as follows:

1.	tik	tiyk	tis	tiys
	===	===	===	===
2.	tis	tiys	tiz	tiyz
	===	===	===	===
3.	kas	kis	tas	tis
	===	===	===	===
4.	kas	kaws	kaz	kawz
	===	===	===	===
5.	kas	kis	kiys	kaws
	===	===	===	===

Each line of the above is read at the rate of about one syllable per second. After the fifth line is read, the examinee is told to go back to line 1, where one and only one of the syllables is to be read; he is told to identify which syllable is read by marking the space provided under the syllable. Similarly, single syllables are read for each of the successive lines and the examinee is to try to identify them. In all, the test contains 30 items similar to the above, organized in groups of five for testing purposes. This subtest, including all instructions, lasts about 15 minutes. A variety of phonemic symbols or digraphs are introduced: š, ž, g, ǰ, e, ey, ay, č, d, ə, æ, θ, ð, in addition to those introduced in the first five items.

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* This "tradename" was originated by Dr. Aaron S. Carton when he was a research assistant to the writer working on an early version of the Grafdrils in 1958.

Obviously, this test depends a great deal upon prior learning in the examinee; it would be much too difficult, at the rate at which it is presented, if the individual did not already know something about English graphemes and their phonemic correspondences. As a test of aptitude, the pacing of the test is rigidly controlled in such a way that only a relatively small number of examinees achieve perfect scores. Presumably, however, a large number of individuals could make perfect scores if the test were made much longer, paced more slowly, and constructed with greater amounts of repetitive practice. Furthermore, to make the test into a proper teaching device, provision would have to be made for supplying examinees with "feedback" as to the correctness or incorrectness of their answers at every step.

The construction of a program for teaching the Arabic writing system, patterned after the Phonetic Script Test, employed the same basic device of presenting correlated visual and auditory stimuli arranged so that new correspondences could be introduced gradually. However, the rate of introduction of new material was drastically reduced, there was a greater amount of repetition in the material, and feedback of information as to the correctness of the learner's response was always immediate. Because of the large number of grapheme-phoneme correspondences which had to be learned in order to master the Arabic writing system, and because of the desirability of having the learner attain a very well-practiced state of learning, the program had to be much longer than any conventional test. In fact, the program had a total running time of 9 hours 38 minutes even if there were no parts of it repeated; the average amount of time spent on it by the subjects approximated 14 hours.

DESCRIPTION OF THE FINAL FORM OF THE ARABIC GRAFDRIL MATERIAL

Chiefly responsible for the actual development of the Arabic Grafdril material was Mr. Graham Leonard, a student at the Graduate School of Education with considerable training and experience in spoken and written Arabic. At various times, Mr. Leonard was assisted by the writer and by Aaron S. Carton, who was at that time a student at the Graduate School of Education interested in foreign language teaching.

The Arabic Grafdrils evolved through three versions; the version used in the experiment described in this report is regarded as a "tentative final version," in the sense that it is the result of much prior development and there are no immediate plans to revise or improve it.

The earliest version of Arabic Grafdrils was developed in the summer of 1958 and tried out with a small number of volunteer students in the Middle-East Inter-University Summer Program which was held at Harvard at that time. Results with the Grafdrils were promising; not only did all students appear to achieve satisfactory learning, but it appeared that low-aptitude students were the ones who especially profited from the Grafdril method as compared to the traditional procedure of studying a textbook presentation of the Arabic writing system.

A second, improved version was developed subsequently, partly based on information concerning students' performances on Grafdril Version I and their reactions to it. This version was tried informally on a number of students; results were used in formulating a third and final version of the material.

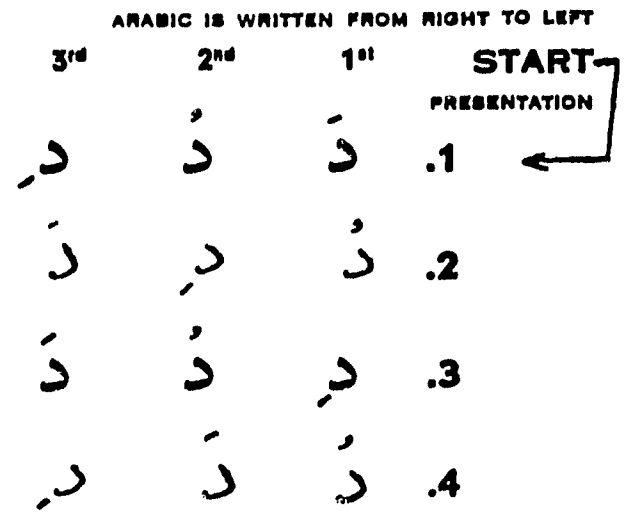
The basic plan of all versions has been roughly the same. The materials consist of a series of expendable sheets of paper printed with practice materials in Arabic writing; each sheet constitutes one lesson of the course and is accompanied by a tape recording which gives all instructions for proceeding and all the auditory stimuli in Arabic which the learner has to learn to identify in written form on the page before him.

For the third version of Grafdrils, the unit sheets were printed in Lebanon; the voice on the tape is that of a native speaker of Arabic chosen for his clarity of articulation and naturalness of dialect.*

The sheets for Grafdrils I and XV are reproduced and shown in Appendices A and B, respectively, with their accompanying tape-scripts. The actual size of the sheets is 9 3/4 x 13 5/8 inches.

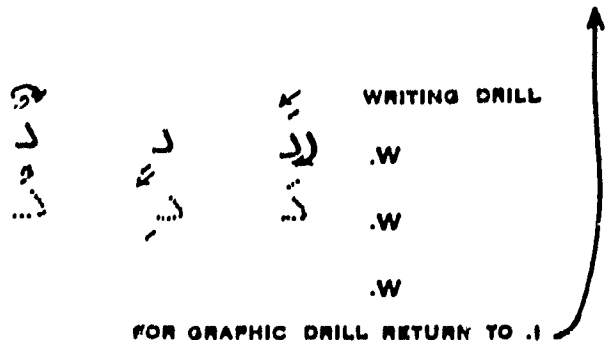
Grafdril I, which sets the pattern for nearly all the remaining Grafdrils, will now be described in detail.

The first portion is at the upper right, and appears as follows:



The first four items are used for "presentation" of the new materials to be learned. The syllables denoted by the Arabic writing are spoken, one after the other, while the learner is directed to look at each, listen to the corresponding sound, say the sound aloud ("mimic" it), and then listen to a second rendition of the sound. The sounding of the syllables is interspersed with any necessary explanations. For example, in item 1 it is explained that the consonant occurring in each of the three writings is the same and is roughly equivalent to the English "d", while the signs above and below the letter are the vowels sounded after the consonants. Odd-numbered lines are in printing, even-numbered lines in handwriting.

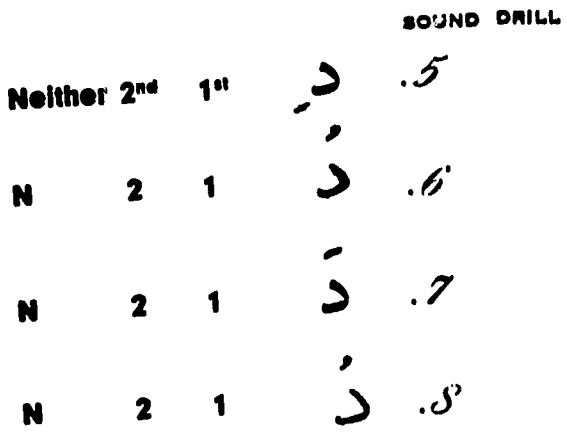
Next, the learner is to practice writing the graphemes just introduced. The first line of the following material indicates stroke order and direction; the learner is to trace over the material in the second line, and then make a fresh copy in the third line:



* The tapes use Modern Classical Arabic, a form of spoken Arabic which is used with only minor variations in all Arabic-speaking countries. The informant is a Palestinian from Bethlehem.

After the writing drill, the learner is to return to observing line 1. But for this "graphic drill," as it is called, the learner is to listen to the one syllable rendered on the tape and underline the corresponding written syllable. For example, in item 1 the voice on the tape says "da," and the learner is to underline the first syllable. (It should be noted that syllables are numbered from right to left, to correspond with the Arabic convention.) Four or five seconds are allowed for the subject to underline the syllable heard, after which the voice says "first," "second," or "third" to indicate the correct answer. The correct Arabic pronunciation is then spoken on the tape for immediate reinforcement. The subject is to circle the correct answer if his choice has been incorrect. Items 2, 3, and 4 are performed similarly.

Next the subject skips down to item 5, marked "SOUND DRILL." He is told that he must look at



the Arabic writing in item 5, and then listen as the voice on the tape utters <u>two</u> syllables or words. As he does so, he follows along the response positions "1," "2" and "Neither" (printed from right to left, however), underlining whichever position indicates which one of the two spoken syllables or words was the correct reading of the Arabic writing. After a very brief interval, the English voice on the tape indicates which was actually the correct answer, and the Arabic voice then repeats it. For example, the Arabic writing in item 5 is to be read "di"; the Arabic voice utters the two syllables "di" and "da," and therefore the subject should mark "1." In item 6, the Arabic writing is to be read "du"; the Arabic voice utters the two words "da" and "di," and therefore the correct answer is N (Neither).

At the completion of the "sound drill," the subject starts a new presentation unit at item 9. Items 9-16 are organized in the same basic pattern as items 1-8; that is, the four basic parts of the cycle are: Presentation, Writing Drill, Graphic Drill over the same material as the Presentation, and finally, Sound Drill. The whole page contains four such segments; items 1-8 (upper right), items 9-16 (lower right), items 17-24 (upper left), and items 25-32 (lower left).

In actual use, it is intended that a subject proceed through the whole of a Grafdril at the pace set on the tape; this pace is set slow enough, it is believed, for the learner to profit to the maximal extent from each rendition of the tape. The learner may choose, however, to repeat the tape; it is also possible that in individualized use, a learner might wish to stop the tape temporarily or repeat particular portions of it.

Each half of a Grafdril lesson introduces one or more new letters or other features of the Arabic writing system. The rate of introduction is carefully moderated so that the learner is not confronted with too many new items at once. In the case of Grafdril I, items 1-8 introduce the consonant letter "d," and the three short vowel marks "a," "i," "u"; items 9-16 introduce the mark known as <u>sukuun</u> (to indicate that a consonant has no following vowel); items 17-24 introduce the signs for the long vowels "aa" and "uu"; items 25-32 introduce the sign for the long vowel "ii."

Table 1 shows what graphs or other features are introduced for the first time in each of the twenty Grafdrils.

Each Grafdril lesson is accompanied by two other forms of practice or drill: Writing Practice, and Dictation Drill. The Writing Practice (for an example, see Appendix C) is an extension of the Writing Drill included in the Grafdril itself. Essentially, the subject practices writing the forms of Arabic letters, paced by instructions and hints given on the accompanying tape

Table 1

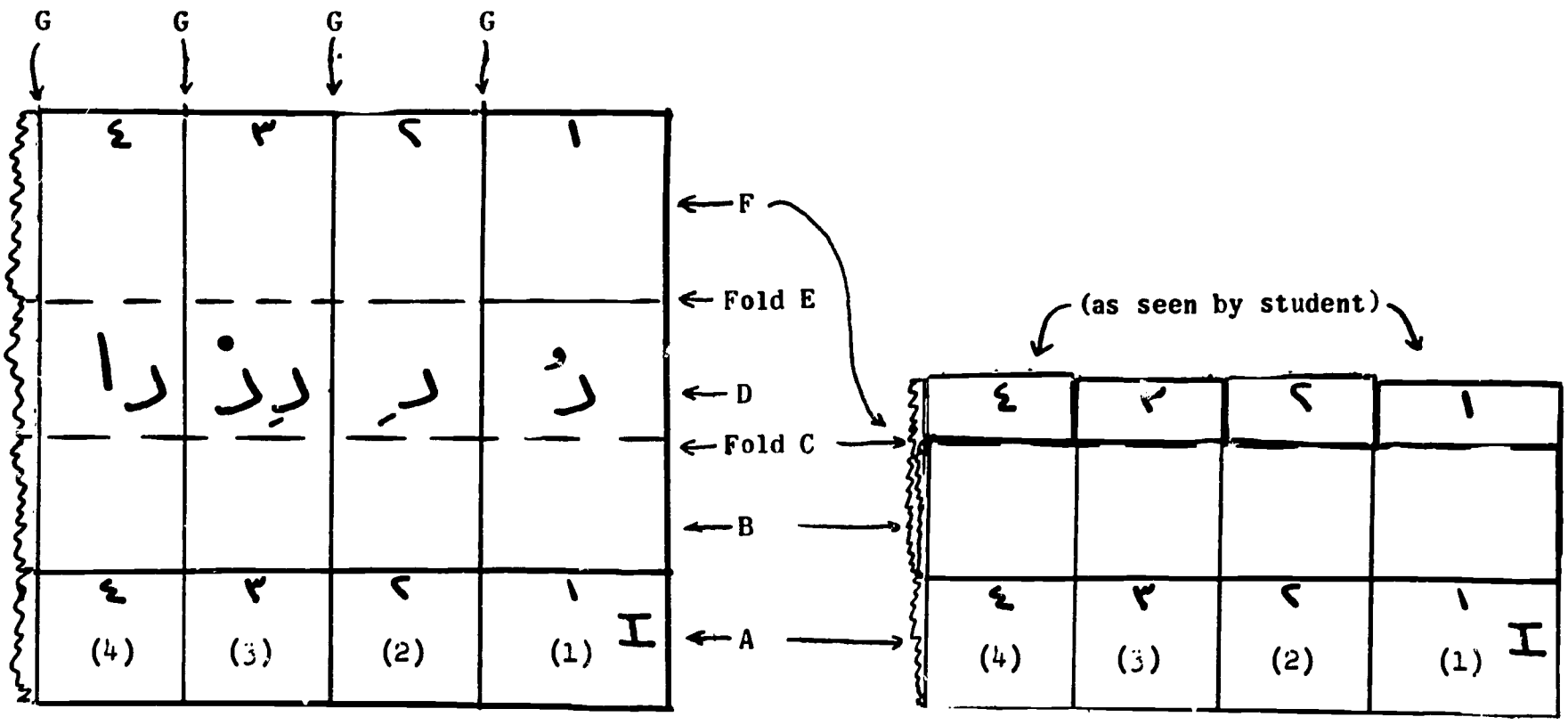
Arabic Letters Newly Introduced in Each Grafdril*

The Roman letters in parentheses have the following meanings:
U : Unconnected Form
I : Initial Form
M : Medial Form
T : Terminal Form

Grafdril No.	Items Introduced
I	daal(U); 3 short vowel marks (fatḥah, ḍammah, kasrah); 'alif(U); waaw(U); yaa'(U); sukuun
II	jiim(U); zaay(U); miim(U)
III	šiin(U); faa'(U); kaaf(U); doubling of letters with šaddah
IV	'alif(T), daal(T), zaay(T), šiin(I,M,T), faa'(I,M,T), kaaf(T), waaw(T), yaa'(I,M,T); begins connection of letters
V	iim(I,M,T), kaaf(I,M), miim(I,M,T)
VI	ṭaa'(U,I,M,T), haa(U,I,M,T); nunation (fatḥatáan, ḍammatáan, kasratáan)
VII	Consonantal waaw(U,T), Consonantal yaa'(U,I,M,T); Diphthongs aw and ay
VIII	baa'(U,I,M,T), ðaal(U,T)
IX	xaa'(U,I,M,T), raa'(U,T)
X	siin(U,I,M,T), ṣaad(U,I,M,T)
XI	taa'(U,I,M,T), ġayn(U,I,M,T)
XII	ẓaa'(U,I,M,T), laam(U,I,M,T), laam 'alif (U,T)
XIII	ḥaa'(U,I,M,T), nuun(U,I,M,T)
XIV	ṣaad(U,I,M,T), qaaf(U,I,M,T)
XV	θaa'(U,I,M,T), ᶜayn(U,I,M,T)
XVI	hamzah (12 variants)
XVII	taa' marbuuṭah (U,T), 'alif maqṣuurah (U,T); adjectives and their forms
XVIII	Definite article; sun and moon letters; typewritten forms
XIX	- - -
XX	- - -

* The spelling of the letters in the Arabic alphabet is in accordance with Rice (1959).

recording.* The Dictation Drill presents a series of spoken Arabic words, each of which is to be written by the subject in a particular space provided. The material is printed and folded in such a way that after each written response of the subject, he can pull a tab and compare his response with the correct answer. If he sees that his response is wrong, he can write a correction in a space provided for the purpose. Here is a sample from the first Dictation Drill:



The numbers of the items are given in both Western and Arabic forms in the line marked A. The subject is to write from dictation in the line marked B. In use, the material is folded under on lines C and E so that the Arabic writing printed on line D is not visible until the learner pulls the tab formed by line E. He can write a corrected response on line F if he sees that his writing on line B compares unfavorably with the correct response in line D. The vertical cuts indicated at G to fold C make the tabs operate individually.

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* In the present experiment, only one Writing Practice Sheet was used in the regular learning sessions. Instead, Sheets were given out to be worked on at home. About half the subjects reported devoting some time to these.

SOME REMARKS ON

THE PSYCHOLOGICAL LEARNING PRINCIPLES

INCORPORATED IN THE GRAFDRIL MATERIAL

The Presentation phase of the Grafdril cycle presents correlated auditory and visual stimuli. The first task of the learner is to perceive these stimuli as identified units (Gibson, 1950) and observe how they correspond. Some help is given the learner through verbal explanations, but in the last analysis it is the learner's own task to perceive the relationships. The material is organized so that the learner can easily perceive what is constant and what is varying in the stimulus display; he sorts out the correspondence relationships by identifying which aspects of the visual display vary concomitantly with certain aspects of the auditory display. Although there is no overt manifestation of learning at the end of the presentation phase, it may be assumed that an attentive subject has learned something from it. That is, he has identified the stimulus units and has noticed the correspondences between them.

The Writing Drill calls attention to the particular forms of the written characters and further helps the learner make identifying responses to them. It forces him to make an overt response in the shape of particular letter forms. It does not, however, ask him yet to recall this response.

The Graphic Drill tests the subject's ability to connect sound and letter and is the first performance depending in any way upon retention of something already learned. Because of the structure of the exercise, the cues available to the subject may be numerous, and he may be able to arrive at a correct response on the basis of only a limited number of these cues. For example, if the three words presented start with three different letters, he can choose the correct answer solely on the basis of recognition of the first letter as corresponding to the initial phoneme of the word heard on the tape, without concern for the correspondences exemplified in the remainder of the word. The programming of these exercises has to lead the learner to pay attention to more and more different cues.

The learning principle that the learner is aided by immediate knowledge of results is illustrated in this so-called Graphic Drill, because after making his response, the learner is immediately told which answer is correct, and his attention is again called to the correct reading of the Arabic writing.

The Sound Drill, so called, requires an even more precise response on the part of the learner. Because of the possibility that "Neither" of the two syllables spoken on the tape corresponds to the written material, the subject must respond with sufficient precision to the written material so that he can decide how to answer. The alternatives presented on the tape are always close enough to the correct answer so that the learner must exhibit careful discrimination. The Sound Drill phase is as close as one can come, in programmed self-instructional materials, to the objective testing of "reading Arabic writing" in the sense of responding to Arabic graphemic material with a reconstruction of the spoken form.

The Writing Practice, performed after the Grafdril lesson, gives further practice in writing Arabic forms, in a purely imitative way. Immediate knowledge of results occurs when the learner compares his response with the model.

The Dictation Drill, performed after the whole of a Grafdril lesson (or in most cases, after a set of lessons), provides a review of material learned in the previous lessons and requires active response on the basis of retention of these materials. It is similar to a test, but provides immediate knowledge of results after every item. If the subject has not fixated his learning by the time he gets to the dictation drill, it offers a further opportunity for him to do so.

The total organization of the Grafdril materials is intended to exemplify the principle that the learner can learn only one item (or a small number of items) at a time. Each item or feature of the Arabic writing system is introduced and put forward in the center of the stage, so to speak, at a certain point in the program and displayed or repeated sufficiently to enhance the probability that learning will occur. The item or feature is then gradually withdrawn to the background, but it is repeated enough to make a semi-permanent kind of retention possible. So little is known concerning the optimal rate at which new material should be introduced and reinforced that the construction of the program from this standpoint had to be done solely by a kind of educated intuition.

After the XVIth Grafdril, a "panel" of Arabic alphabetic forms was made available to the subjects to allow them to compare the variations of each letter in printing and handwriting. This helped the subjects to appreciate the total extent of the learning task and to perceive the relationships among its parts.

THE EXPERIMENT

Early in the summer of 1962, the present version of the Grafdrils was used with a number of students who were starting to study Arabic in the Harvard Summer School. Because of the confusion attendant upon the opening of the summer school and the unexpectedly large number of students, the Arabic instructors were not able to give the kind of full cooperation which they had given in the experiment conducted in 1958, with the result that it was impossible to conduct with these students the careful, controlled experiment which had been planned. Furthermore, because of the large demands put upon them the language laboratory facilities of Harvard were not available for the experiment.

Consequently, it was decided to conduct a carefully controlled experiment using subjects especially recruited for the purpose and paid for their time. Arrangements were made to utilize the language laboratory facilities at Massachusetts Institute of Technology and to obtain subjects through the facilities of the student employment bureau there.

In preparation for the experiment, the taped portions of the Grafdrils were copied into cartridges of the sort employed in the Linguatrainer facilities of the M.I.T. language laboratory. Since these cartridges can contain a maximum of 15 minutes' worth of recording, the materials had to be broken down into from 2 to 4 sections per Grafdril unit. Thus, there were 58 cartridges in all to cover the recorded material for the 20 Grafdril units; the total running time was 527 minutes, or 8 hours 47 minutes. In addition, cartridges were made of the Dictation drills; there were 16 of these, with a total running time of about 80 minutes. There was also one Writing Drill (2 cartridges totaling 10 minutes).

To conduct a control group parallel to the experimental group, an experienced instructor of Arabic was recruited and briefed on the requirements of the instructional task.

Subjects

Within the limits imposed by the circumstances, a simple experimental design was established in which there were to be experimental and control groups paired on an appropriate control variable. The most appropriate variable available seemed to be the total score on the Carroll-Sapon Modern Language Aptitude Test because it is generally a good predictor of progress in intensive language learning (Carroll, 1962). Accordingly, to obtain a sample from which experimental and control groups could be chosen, 95 paid subjects were recruited and given the "long form" of the MLAT (i.e., the complete test with all five subtests). Sixty persons (plus a short list of "alternates," or standbys) were chosen for the experiment, 30 each for the experimental and control groups. Pairing was based primarily on percentile ranks for the total MLAT score; percentile ranks had been determined by reference to whatever norm table in the MLAT manual appeared to be most appropriate for each individual. When possible, individuals were paired also on the basis of sex and age.

The 60 persons chosen for the experiment in this way consisted of 52 persons (students, students' wives, or employees) recruited by the M.I.T. Office of Student Personnel, and 8 students from Cambridge high schools. Of the 60, only 6 failed to complete the experiment, either because of a falling off of interest, or because of circumstances beyond their control.

In choosing the experimental and control groups, an effort was made to include individuals distributed rather evenly throughout all levels of the possible range of scores on the MLAT. The distribution of scores was, however, rather substantially skewed in a negative direction; most of the raw scores fell above 120. The distributions of MLAT scores of the experimental and control groups as finally constituted are shown in Table 2.

Experimental training

The experimental training was conducted in the M. I. T. language laboratory on five consecutive evenings (Monday through Friday) in sessions that lasted approximately 3 hours each. Students sat in individual booths and listened to the taped materials while they worked on the Grafdril unit sheets. Although Mr. Leonard (research assistant) and a language laboratory technician were present at all times, students received no direct help or instruction from them of any kind other than with reference to purely mechanical matters.

Of 27 students who started experimental training, 26 completed it. Two students missed an evening apiece and had to make up lessons. The promptness, regularity of attendance, and diligence of these students were exceptionally good; this may, of course, have been due more to the remuneration offered than to the intrinsic interest of the Grafdril materials. The motivational aspects of the Grafdril materials cannot be properly assessed until they are tried out in a normal classroom learning situation. Nevertheless, the 3-hour period of constant taped instruction was felt to be excessively long by both subjects and the observing supervisors. The work was especially taxing for the high school subjects and the subjects who had low MLAT scores.

After each cartridge (containing generally one-half of a Grafdril unit) was played, any student could elect to have it repeated for him, or even to call for the playing of an earlier cartridge in the series. Approximately two-thirds of the group went straight through the program without repetitions. To a large extent, this was a function of the limited time that was to be available for the experiment, for both the Experimental and Control groups were operated under the time limitation of five evening sessions during one week, with the final test scheduled for the last half hour of the fifth evening. It would have been preferable to spread the instruction over a longer period, but this did not appear practicable. Those who elected to have tapes repeated knew that they might be obliged to spend extra time, by coming early to sessions or staying late, to catch up with the group. There were in any case sufficient requests for repeats to necessitate playing as many as eight different cartridges simultaneously. In general, it was the high aptitude students who were more likely to request repeats of tapes, and these subjects tended also to score higher on the final examination. It may be that greater benefit for those of lower MLAT scores would have been achieved if there had been more time to cover the material and more individual choice as to length of session. The total amount of time spent by the students on the Grafdrils and associated materials (exclusive of the final test) ranged from 10 to 14 hours.

Control training

Control instruction was given in a regular classroom on the M.I.T. campus by a native Arabic-speaking (Egyptian) instructor, Mr. Wilson Bishai, who possesses linguistic training and considerable experience as an instructor of Arabic. This instruction was scheduled at the same times as the experimental training. On each of the 5 evenings there were approximately 1 3/4 hours of classroom instruction. On the first four evenings, the classroom instruction was followed by 1 hour of supervised study, while on the fifth evening, it was followed by the final test, given at the same time as it was given to the Experimental Group. The instructor of the Control Group taught as he thought best, using materials he had devised for the purpose. [These did not include Frank Rice's The Classical Arabic Writing System (Rice, 1959).] However, Mr. Bishai was not allowed to inspect or utilize the Grafdrils or any portion thereof. Mr. Bishai reported that he made every effort to teach so that his group would stand a good chance of excelling the Experimental Group on the final criterion test.

Of 31 students who started training in the control group, 28 completed.

Table 2

Frequency Distributions, Modern Language Aptitude Test Total Score,

M. I. T. Experimental and Control Groups

Score Interval	Experimental Group (N = 26) f	Control Group (N = 27) f	Approximate Percentile Rank, Adult Norms *
175-179	1	1	99
170-174	1		98
165-169		2	97
160-164	1	2	96
155-159	2		95
150-154	5	3	89
145-149	2	3	83
140-144	4	5	77
135-139	1	2	72
130-134	1	1	67
125-129		2	62
120-124	1	2	57
115-119	1	1	52
110-114	1	1	47
105-109	1		42
100-104			37
95-99			32
90-94	1		28
85-89	1	1	25
80-84		1	20
75-79			16
70-74	1		13
65-69	1		8
60-64			6
Mean	135.8	138.7	

* Estimated from norms for "Men in Intensive Language Training (Department of State)," Table 3, Manual, Modern Language Aptitude Test (Carroll and Sapon, 1959).

A further control group

In the fall of 1962, it became possible to collect additional control group data in a condition approximating that of the usual classroom situation. These data were obtained for a total of 13 individuals who started Classical Arabic courses in Harvard. The MLAT was administered to each person as soon as possible after the start of the semester. One week after the start of the semester, students had been told to learn the Arabic writing system in the traditional manner. The achievement test on the Arabic writing was given to them after 12.5 hours of classroom instruction.* It was also learned that some of these individuals had had some prior experience with Arabic. In the data analysis, this group will be referred to as the Harvard Control Group.

The criterion test

The final criterion test was prepared by Mr. Richard Hare, an instructor of Arabic in the Harvard University Summer School, solely on the basis of content and format specifications supplied by Mr. Leonard and without the benefit of an inspection of the Grafdril materials. This precaution was taken in order not to bias the test toward the particular content or format of the Grafdrils. Mr. Leonard's instructions to Mr. Hare are shown in Appendix D, and the test itself (or at least the printed aspect of it) is presented as Appendix E, the tape script for the test being shown as Appendix F.

The test consisted of four parts, with a maximum score of 100. In Part I, 15 pairs of minimally different Arabic words were shown in written form, and the subject was to underline which word he heard spoken on a tape (2 points each correct answer). Part II presented 15 written Arabic words; in the case of each word, the subject had to indicate whether the word was the first, the second, or neither of the two Arabic words read in succession on a tape (2 points for each correct answer); Part III presented 10 spoken Arabic words on tape, the subjects being required to write these in Arabic with vowelling (total of 2 points each word, with part scores for partially correct answers); and Part IV presented 6 words written in Arabic, subjects being required to write the free form of each letter (20 points assigned to this part, one point per letter). The pacing of the test as recorded was considerably faster than intended due to the unwitting use of a stopwatch calibrated in 1/100's of a minute rather than in seconds.

The test was given from a Wollensak tape-recorder placed in the center of a classroom. Experimental and control classes took the test in the same room and at the same time.

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* These 13 students claimed an average of 28 hours of outside study including an average of three hours in the language laboratory.

RESULTS

For the Experimental Group (N = 26), total scores on the criterion test ranged from 32 1/2 to 80, with a mean of 65.0. For the Control Group (N = 28), scores ranged from 28 to 68 1/2, with a mean of 58.1. The difference in means is 6.9 in favor of the experimental group; by a conventional t-test for uncorrelated means, this difference is significant at the 5% level.

In establishing the experimental and control groups, pairs were chosen on the basis of MLAT Total Score percentiles. It was hoped that significance of results could be assessed by examining the differences in criterion test scores for members of these pairs. It was seen, however, that pairing on the basis of percentiles was inappropriate when percentiles were derived from different norm tables for the members of pairs.

It was therefore decided to rely on analysis of covariance to assess the significance of the differences in results for experimental and control groups. The raw data for total scores on MLAT and final criterion test are presented, however, in Table 3 so that the reader may if he wishes perform other statistical operations on them. The data of Table 3 are plotted in Figure 1; inspection of this plot discloses that members of the experimental group performed generally better than control group members possessing similar levels of MLAT score; this superiority was of roughly the same magnitude at all levels of MLAT scores. That is to say, the hypothesis that programmed instruction would be of more benefit to the low aptitude students than the high aptitude students was not confirmed by our data; instead, the benefit seems to accrue for all levels of aptitude. It is possible that low aptitude subjects would show greater benefit if they were not under time pressure and could repeat Grafdrils at leisure.

Analysis of covariance is a statistical procedure by which experimental data for two or more groups may be compared after a statistical adjustment has been made for the effects of any differences in group characteristics which might otherwise bias the results. For example, in the present case the control group is on the average slightly superior to the experimental group in MLAT Total Score; in interpreting the fact that the experimental group had a higher average score (64.29) on the final achievement test than the control group (which had an average score of 57.26), it could be argued that the difference would have been even greater if the groups had been better matched (assuming that language aptitude as measured by the MLAT is relevant to performance on the criterion test). The analysis of covariance technique makes possible an exact test of the plausibility of this argument. Not only does it estimate what the criterion test means of the experimental and control groups might have been if the groups had been perfectly matched, but it tests the statistical significance of the difference between means.*

The use of the technique is illustrated in Table 4, where the M.I.T. experimental and control groups are compared with respect to part and total scores on the final test for knowledge of the Arabic writing system; total scores on the Modern Language Aptitude Test are used for the control variable or "covariate." The table shows first (first line of entries) the extent to which the MLAT score did indeed correlate with performance on the criterion test; the greater the magnitude of this correlation, the larger the adjustment that was made for any difference in MLAT scores between the groups. Next, the table shows, in the first column, the raw means of the experimental, control, and combined groups on the control variable, and at the right, the estimated "adjusted" means of the dependent variables being considered in the analysis, that is, the part and total scores on the achievement test. Actually, Table 4 shows results for five separate analysis of covariance computations, one for each subtest of the final achievement examination, and one for the total score of this same examination.

The relative magnitude of the adjusted test means can be assessed with reference to the maximum possible scores shown in the next line of the table.

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* A discussion of the analysis of covariance technique and the mathematical formulas used in its computation can be found in texts on statistical methods, e.g. that of McNemar (1955).

Table 3

MLAT Total Scores and Final Achievement Test Scores,

M. I. T. Experimental and Control Groups

Experimental Group		Control Group	
MLAT	Achvt.	MLAT	Achvt.
156	60.0	135	42.0
89	47.5	81	28.0
153	64.5	165	66.0
142	72.0	121	61.5
119	58.5	130	55.5
65	32.5	128	50.5
74	36.5	146	57.0
105	40.5	161	58.0
133	59.0	163	67.0
152	74.0	166	63.0
146	61.0	152	58.5
159	75.5	128	64.0
149	69.5	143	56.0
154	66.0	144	62.0
164	77.0	144	43.0
140	66.5	135	63.5
123	64.0	151	64.5
144	72.0	140	63.5
93	62.0	89	43.5
153	71.5	119	54.0
174	67.0	114	68.5
114	70.5	148	65.5
175	81.0	144	54.5
137	67.5	154	56.0
154	75.5	176	64.0
144	80.0	124	54.0
		146	63.5

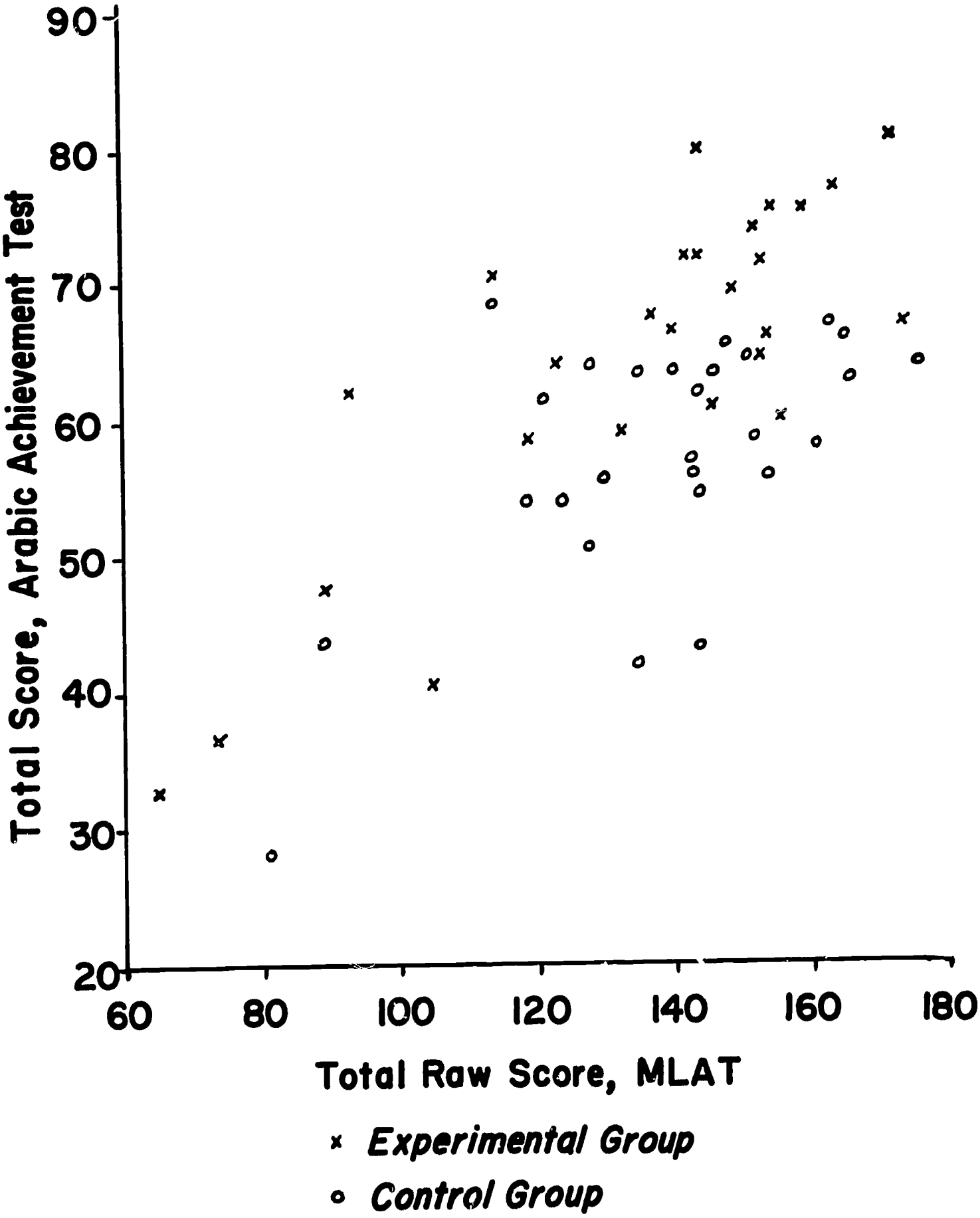

Fig. 1 Scatterplot of MLAT Total Scores with Final Achievement Total Scores, M. I. T. Experimental and Control Groups.

Table 4

Comparisons of Performance of M. I. T. Experimental and Control Groups on Total and Part Scores of Final Achievement Test, Using Total Score on the Modern Language Aptitude Test as a Covariate

Experimental Group: N = 26

Control Group: N = 27

Intercorrelations, Combined Groups (N = 53)

	MLAT Total	Achievement Test I	II	III	IV	Total
MLAT Total	1.00	.37	.25	.73	.71	.70

Raw Means, MLAT Total		Adjusted Means, Achievement Test I	II	III	IV	Total
Experimental Group:	135.8	20.6	15.5	12.2	16.4	64.8
Control Group:	138.7	18.3	11.8	10.4	16.3	56.8
Combined Groups:	137.3	19.4	13.6	11.3	16.4	60.7
Maximum Possible Score		(30)	(30)	(20)	(20)	(100)
F-ratio*		4.2	17.4	8.5	0.0	15.3
P		<.05	<.0005	<.01	ns	<.0005

* Each F-ratio is to be interpreted with $n_1 = 1$, $n_2 = 50$.

The last two lines of the table have to do with the statistical significance of the differences between pairs of adjusted means. The F-ratio is a statistic derived from the data; it is evaluated by determining (from appropriate statistical tables) the probability with which a given ratio might arise on the basis of pure chance. These probability values are listed in the last line of the table; the designation "ns" means "not significant" because the probability value of the F-ratio is greater than the level (.05) that would be accepted as denoting statistical significance.

With these explanations, we may now turn to the consideration of the substantive results of the analyses.

For the comparison of the M.I.T. experimental and control groups, two analyses were run: one using the MLAT total score as the covariate, and one using all five subtests of the MLAT score as the covariates. These results are shown in Tables 4 and 5 respectively.

Table 4, using only the MLAT total score as a covariate, shows clear differences in favor of the experimental group for the total achievement test score and also for all parts thereof except Part IV. Part IV of the achievement test, it will be remembered, required Ss to write the free forms of Arabic letters. The results show that this test was quite easy for all concerned, and it is reasonable to suppose that there would be no particular advantage in the Grafdril technique for learning such easy tasks. The part of the test which revealed the largest relative difference in adjusted means was Part II, which required Ss to look at a written Arabic word and indicate which of two spoken renditions, if any, was correct.

Of all the parts of the achievement test, this task can be regarded as closest to the ultimate criterion performance desired of students, i.e. the ability to respond quickly to a written Arabic word by reconstructing the spoken equivalent. Part III also showed highly significant differences between groups after covariance adjustment; this is another task close to ultimate criterion performance, that is, the ability to write Arabic words from dictation.*

Table 5 extends the analysis by considering all five subtests of the MLAT as covariates simultaneously. As might be expected, the significance levels attained are slightly higher in Table 5 than in Table 4, because use of 5 simultaneous covariates effects greater statistical control. Of particular interest is the fact that highly significant differences are obtained between experimental and control groups even when the dependent variable (the achievement test or one of its parts) is not particularly highly correlated with the control variables. This is the case with Part II of the achievement test, where even in the combined groups the highest correlation between that part and any subtest of the MLAT is only .35, significant at the 1% level but still far lower than some of the correlations between MLAT subtests and other parts of the achievement test. For example, Subtest 2 of the MLAT shows a distinct tendency to correlate with certain parts of the achievement test: $r = .73$ with Part III, for example. One might fear that this means that the Grafdril technique, having been derived from the testing technique utilized in Subtest 2 of the MLAT, does nothing but accentuate individual differences in whatever ability is measured by that subtest and impose them on the distribution of ability in learning Arabic. The fact that this does not happen in at least some of the parts of the Arabic achievement test, notably Part II, is reassuring.

The case of Part IV of the achievement test is at the opposite extreme: the experimental and control groups show virtually the same adjusted means, but ability in this test is highly related to MLAT scores, particularly to Subtests 2 and 5. Even the Grafdril technique seems not to be able to overcome individual differences in language aptitude when it comes to learning to write free forms of Arabic letters.

In an effort to understand the role of aptitude, particularly the aptitude measured by the Phonetic Script Test, scores on Parts II and III of the achievement test have been plotted against scores on Subtest 2 of the MLAT, in Figures 2 and 3, respectively. In Figure 2 it is evident that while there is a rather high correlation between predictor and criterion for the experimental

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* The control group instructor emphasized dictation and predicted that the control group would be far superior to the experimental group on that section of the criterion test.

Table 5

Comparisons of Performance of M. I. T. Experimental and Control Groups on Total and Part Scores of Final Achievement Test, Using Five Subtests of the Modern Language Aptitude Test as Covariates

Experimental Group: N = 26

Control Group: N = 27

Intercorrelations, Combined Groups (N = 53)

	MLAT Subtests					Achievement Test				
	1	2	3	4	5	I	II	III	IV	Total
1	1.00	.42	.32	.41	.44	.27	.13	.44	.40	.42
2	.42	1.00	.58	.54	.69	.44	.28	.73	.63	.71
3	.32	.58	1.00	.36	.41	.22	.15	.46	.49	.45
4	.41	.54	.36	1.00	.54	.20	.35	.57	.56	.57
5	.44	.69	.41	.54	1.00	.39	.06	.67	.69	.62

	Raw Means, MLAT Subtests					Adjusted Means, Achievement Test				
	1	2	3	4	5	I	II	III	IV	Total
Exp.Grp.	36.6	26.2	23.2	31.0	18.8	20.8	15.4	12.4	16.6	65.2
Cntl.Gp.	35.6	26.8	25.2	30.8	20.4	18.2	11.9	10.2	16.1	56.4
Combined	36.1	26.5	24.2	30.9	19.6	19.4	13.6	11.3	16.4	60.7
			Maximum Possible Score			(30)	(30)	(20)	(20)	(100)
			F-ratio*			5.8	16.4	13.4	0.4	22.3
			P			<.025	<.0005	<.001	ns	<.0005

* Each F-ratio is to be interpreted with $n_1 = 1$, $n_2 = 46$.

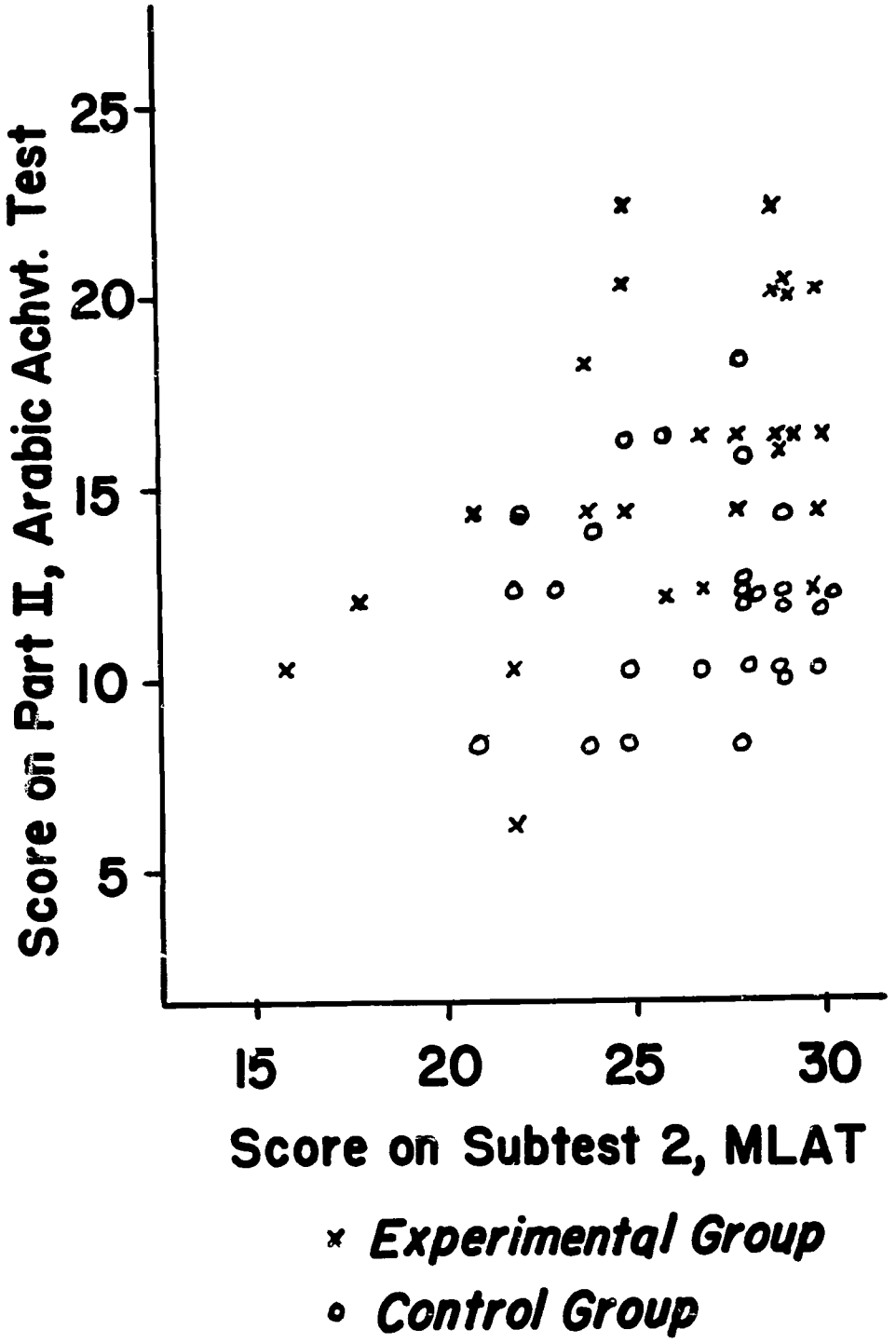

Figure 2. Scatterplot of MLAT Part 2 Score with Final Achievement Test Part II Score, M. I. T. Experimental and Control Groups

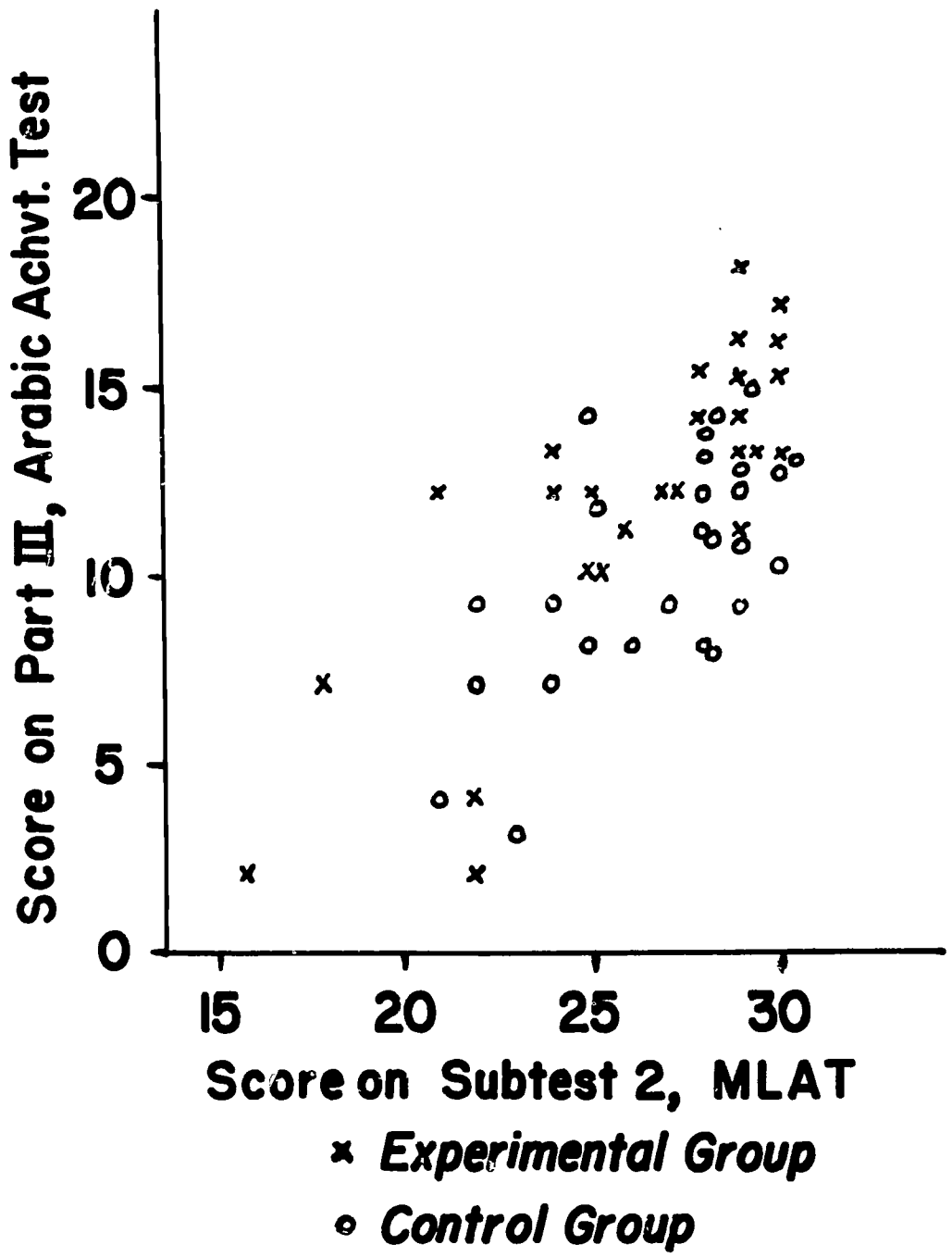

Figure 3. Scatterplot of MLAT Part 2 Score with Final Achievement Test Part III, M.I.T. Experimental and Control Groups

group (r = .51), the correlation is virtually zero for the control group (r = .07).* Apparently, the ability to profit from the Grafdril technique and to demonstrate achievement on Part II of the criterion test is dependent on MLAT score, perhaps because of the similarity of the tasks involved and common abilities demanded in them. For the control group, however, taught by a lecture method, achievement is distinctly inferior, and it is not dependent upon the ability measured by the Phonetic Script subtest of the MLAT.

Figure 3 shows that the Phonetic Script Test predicts amount of benefit gained from either the Grafdril technique or from the lecture method towards achievement on Part III of the criterion test. Nevertheless, it remains true, as shown by the analyses of Tables 4 and 5, that there is more benefit from the Grafdril technique than from the lecture method.

There seems to be little evidence for the hypothesis that low aptitude individuals are helped by the Grafdril technique more than high aptitude individuals. For example, it can be seen from Figures 2 and 3 that even for high aptitude individuals, scores were considerably higher on both Parts II and III of the Arabic writing achievement test.

We turn now to Table 7 showing comparisons between the M. I. T. experimental group, which had learned the Arabic writing system by the Grafdril technique, and the "Harvard control group," which had learned it by self-study in the traditional manner outside of class. This control group was slightly more apt, judging from the MLAT means, than the experimental group, but these differences are presumably eliminated by the analysis of covariance computations. When all cases in the Harvard control group are compared with the experimental group, the experimental group shows a slight, but non-significant superiority. When, however, six cases in the Harvard control group who had had prior training and experience in Arabic are eliminated, the comparison favors the experimental group at a high level of significance. When it is recalled that the Harvard control group should if anything have possessed higher motivation to succeed in Arabic study than the purely volunteer, casual subjects secured at M. I. T., the superiority of the Grafdril technique seems again confirmed.

In any study of teaching methods, there is always the suspicion that the results may be dependent upon the criterion measures employed. In the present case it might be charged that the format of the criterion test was so similar to that of the Grafdril technique itself that the seeming superiority of the Grafdril-trained groups may have been merely a result of their higher degree of practice with this type of testing technique. The only final remedy for such a charge is to see whether some form of test that might satisfy critics as a valid measure would also yield results favoring the experimental group as much as has been the case in the present study.

If we consider this charge, we notice that the format of the criterion test is indeed similar to the Grafdrils. The hearing of correlated visual and auditory stimuli on tape may have been unfamiliar to the control groups. Even more, the format of Part II, which showed large differences between groups and which seemed to confuse the control group completely (in view of the low correlation with MLAT Subtest 2), is highly specialized and resembles that of the Sound Drill sections of the Grafdrils (see p. 5).

On the other hand, the tasks presented in Parts I and III of the Arabic achievement test are not dissimilar to tasks that might have been presented in the control group training conducted by an instructor. Finally, the fact that one of the control groups (the "Harvard control group") performed nearly as well as the Grafdril-trained experimental group demonstrates that the format of the criterion test was not necessarily a bar to showing student achievement.

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* Separate correlation matrices for the M. I. T. experimental and control groups are presented in Table 6.

Table 6

Intercorrelations of MLAT Subtest and Total Scores
with Arabic Final Achievement Subtest and Total Scores

First Cell Entry: MIT Experimental Group (N = 26)
Second Cell Entry: MIT Control Group (N = 27)
Third Cell Entry: Combined Groups (N = 53)

	MLAT						Arabic Final Test					Mean	S. D.
	1	2	3	4	5	Tot.	I	II	III	IV	Tot.		
MLAT Pt.1	1.00	.65	.66	.50	.64	.84	.36	.36	.66	.65	.67	36.65	7.49
	1.00	.15	-.03	.33	.27	.54	.15	-.25	.17	.13	.10	35.59	7.49
	1.00	.42	.32	.41	.44	.69	.27	.13	.44	.40	.42	36.11	7.44
MLAT Pt.2	.65	1.00	.75	.63	.71	.88	.38	.51	.82	.64	.78	26.19	3.84
	.15	1.00	.31	.45	.67	.64	.63	.07	.68	.63	.76	26.78	2.68
	.42	1.00	.58	.54	.69	.79	.44	.28	.73	.63	.71	26.49	3.28
MLAT Pt.3	.66	.75	1.00	.44	.56	.86	.36	.34	.67	.53	.63	23.19	10.71
	-.03	.31	1.00	.29	.21	.63	.11	.03	.26	.44	.32	25.22	9.52
	.32	.58	1.00	.36	.41	.76	.22	.15	.46	.49	.45	24.23	10.08
MLAT Pt.4	.50	.63	.44	1.00	.58	.74	.32	.56	.67	.57	.70	31.04	7.44
	.33	.45	.29	1.00	.51	.79	.08	.19	.50	.56	.48	30.78	8.05
	.41	.54	.36	1.00	.54	.75	.20	.35	.57	.56	.57	30.91	7.68
MLAT Pt.5	.64	.71	.56	.58	1.00	.81	.47	.30	.76	.69	.74	18.77	5.71
	.27	.67	.21	.51	1.00	.70	.42	-.09	.68	.70	.66	20.37	5.39
	.44	.69	.41	.54	1.00	.76	.39	.06	.67	.69	.62	19.58	5.55
MLAT Tot.	.84	.88	.86	.74	.81	1.00	.45	.49	.85	.73	.84	135.85	29.04
	.54	.64	.63	.79	.70	1.00	.31	-.02	.61	.69	.61	138.74	21.83
	.69	.79	.76	.75	.76	1.00	.37	.25	.73	.71	.70	137.32	25.41
Ar.T. I	.36	.38	.36	.32	.47	.45	1.00	.02	.41	.24	.57	20.46	4.47
	.15	.63	.11	.08	.42	.31	1.00	-.02	.28	.29	.62	18.44	3.97
	.27	.44	.22	.20	.39	.37	1.00	.12	.39	.24	.62	19.43	4.30
Ar.T. II	.36	.51	.34	.56	.30	.49	.02	1.00	.58	.47	.67	15.46	4.02
	-.25	.07	.03	.19	-.09	-.02	-.02	1.00	.30	.21	.46	11.85	2.66
	.13	.28	.15	.35	.06	.25	.12	1.00	.52	.31	.65	13.62	3.82
Ar.T.III	.66	.82	.67	.67	.76	.85	.41	.58	1.00	.82	.93	12.10	4.08
	.17	.68	.26	.50	.68	.61	.28	.30	1.00	.74	.83	10.50	3.08
	.44	.73	.46	.57	.67	.73	.39	.52	1.00	.76	.90	11.28	3.66
Ar.T. IV	.65	.64	.53	.57	.69	.73	.24	.47	.82	1.00	.84	16.27	4.35
	.13	.63	.44	.56	.70	.69	.29	.21	.74	1.00	.83	16.46	3.75
	.40	.63	.49	.56	.69	.71	.24	.31	.76	1.00	.78	16.37	4.02
Ar.T.Tot.	.67	.78	.63	.70	.74	.84	.57	.67	.93	.84	1.00	64.29	12.68
	.10	.76	.32	.48	.66	.61	.62	.46	.83	.83	1.00	57.26	9.34
	.42	.71	.45	.57	.62	.70	.62	.65	.90	.78	1.00	60.71	11.56

Table 7

Comparisons of MIT Experimental Group with the Harvard Control Group
on Total Score of the Final Achievement Test
Using Total Score on the Modern Language Aptitude Test as a Covariate,

(A) Using All Cases in the Harvard Control Group, and
(B) Excluding Cases with Prior Training in Arabic.

Experimental Group: N = 26 in both comparisons
Harvard Control Group, all cases: N = 13
Harvard Control Group, exclusive of those with prior training: N = 7

	A. (All Cases)	B. (Selected Control Group)
Raw Means, MLAT Total Score:		
Experimental Group	135.8	135.8
Control Group	143.4	143.0
Combined	138.4	137.4
Correlation, MLAT Total and Total Achievement Score, Combined Groups	.67	.74
Adjusted Means, Achievement Test Total:		
Experimental Group	65.1	64.8
Control Group	62.3	53.1
Combined	64.2	62.3
Degrees of freedom:		
n_1	1	1
n_2	36	30
F-ratio	0.8	15.2
p	ns	< .0005

DISCUSSION

It is almost useless to speculate why the Grafdril technique produced superior performance on the criterion tests. Even if we are justified in believing that the superiority of the Grafdril-trained group was real, the present experiment provides no real explanation for the success of the method. Among the factors that may differentiate the Grafdril technique from conventional classroom instruction or from self-study from a textbook are the following:

1. The Grafdril is a carefully "programmed" course, with carefully regulated introduction of each new aspect. The extent to which an instructor might be able to control such programming is dubious at best. A student working by himself without a device such as the Grafdrils would be hardly likely to organize his learning activities as systematically as a Grafdril student.

2. The Grafdrils are constructed so that the student must constantly keep alert and notice all relevant details if he is to keep up with the instruction. Furthermore, there is immediate knowledge of results, in the sense that the student knows whether each response he makes is correct or not, immediately after he makes it. What we know about principles of learning suggests that knowledge of results is a potent influence on learning. It is not so easy to insure students' continual knowledge of the accuracy of their responses in a classroom learning situation.

3. The Grafdrils provide some opportunity for self-pacing. That is, a student can review a given unit and thereby keep up with the instruction better than he can in a classroom situation. On the other hand, self-study can usually be "paced to taste."

4. The Grafdrils provide constant presentation of correlated auditory and visual stimuli. In the classroom, this might not always occur, and it is likely to be undependable or even totally absent in self-study from a textbook.

For the presentation of information about a writing system and of practice in its use, the Grafdril technique thus appears to be superior to conventional classroom instruction and to self-study from a textbook on almost every count.

It is nevertheless remarkable that this teaching technique seems not to be able to overcome individual differences. At the end of approximately 14 hours of instruction, there was still a wide range of achievement on the part of those who had been taught by Grafdril. This range of achievement was rather highly correlated with ability; in fact, the correlation in the experimental group between MLAT total score and total score on the Arabic achievement test was .84; in the M. I. T. control group the correlation was .61. From this one may conclude that even though it is possible to improve teaching methods for low aptitude students, these same teaching methods are equally beneficial in accelerating the learning of high aptitude students.

The writer has speculated (Carroll, 1962, 1963) that aptitude is properly defined in terms of the amount of time that an individual would require to meet a specified criterion of mastery, under optimal conditions of instruction. If time is held constant, as it was (approximately) in the present experiment, it can be expected that individuals of different levels of aptitude will progress different amounts towards mastery. Conversely, it may be expected that if the level of mastery is held constant, individuals will take different amounts of time in attaining it. It would be interesting to find out whether such an expectation would be borne out if a group of students of Arabic could be persuaded to practice with the Grafdril material long enough to attain a common standard of mastery.

One other hypothesis to be considered is that the high correlation between achievement and ability was due to imperfections in the programming of the Grafdrils. It is possible that this correlation could be reduced, along with a yield of a higher average level of achievement, if the Grafdrils were thoroughly revised in the light of data now available on student performance.

SUMMARY AND CONCLUSIONS

1. This experiment was designed to evaluate the effectiveness of a novel technique for teaching a writing system, called Grafdrils. The Grafdril technique had its origin in a test, the Phonetic Script Test of the Modern Language Aptitude Test. Basically, the technique involves the systematic presentation of correlated visual and auditory stimuli in such a way that a subject can note these correlations and use them in making his responses to problems calling for the matching of a speech response to a visual stimulus or a written response to an auditory stimulus. When this technique is used for instruction, the rate at which new materials are introduced and the schedule whereby the learner is informed of the correctness of his response are such that learning is made as easy as possible.

2. A set of 20 Grafdrils for teaching the Arabic writing system was revised from earlier materials and prepared for use in a language laboratory facility.

3. A formal experiment was designed in which there were to be 30 paid subjects in an experimental group, and 30 similar, matched subjects in a control group. Subjects were chosen so as to be matched as closely as possible on sex, age, and score on the Modern Language Aptitude Test. The experiment was conducted on five successive evenings in sessions lasting approximately three hours each evening. The experimental group was taught the Arabic writing system by means of the Grafdrils specially constructed for this purpose; the control group was taught the same material by an experienced instructor of Arabic. Achievement in learning was tested towards the end of the last session by a half-hour criterion test incorporating four types of exercises in reading and writing the Arabic writing system.

4. Data were collected from one other group, composed of 13 individuals starting to take regular courses in Arabic at Harvard College in the Fall of 1962. These individuals were given the MLAT, and later, the criterion test, after they had had opportunity to study the Arabic writing system from self-study of a textbook.

5. In the formal experiment, data were complete on 26 members of the experimental group and 27 members of the control group. The achievement of the experimental group was clearly and significantly superior to that of the control group on three of the four parts of the criterion test. The fourth test appeared to be too easy to show differences.

6. In both experimental and control groups, a substantial range of individual differences in achievement could be observed at the end of the training period; this variation tended to be substantially related to scores on the Modern Language Aptitude Test. The Grafdril technique made for superior learning, but did not overcome individual differences in aptitude completely. The technique appeared to be equally beneficial for students of all levels of aptitude.

7. When the experimental group, taught by the Grafdril technique, was compared with the Harvard College group, no significant differences in achievement appeared until those members of the group who had had prior experience with Arabic were excluded.

8. It may be concluded that the Grafdril technique is in general a more efficient method of teaching a writing system than either (a) a lecture-type classroom presentation, or (b) self-study from a textbook.

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APPENDICES

APPENDIX A

ARABIC GRAFDRIL No. I

NAME

ARABIC IS WRITTEN FROM RIGHT TO LEFT

2nd	1st		
		PRESENTATION	
دَاذْ	دَذْ	.17	← START
دُوزْ	دُزْ	.18	
دُذْ	دُوذْ	.19	
دَزْ	دَازْ	.20	
		WRITING DRILL	
	ا	.W	
	ى	.W	

FOR GRAPHIC DRILL RETURN TO .17

3rd	2nd	1st		
			PRESENTATION	START →
دِ	دُ	دَ	.1	
	دِ	دُ	.2	
دَ	دُ	دِ	.3	
دِ	دَ	دُ	.4	
			WRITING DRILL	
			.W	
			.W	
			.W	

FOR GRAPHIC DRILL RETURN TO .1

				SOUND DRILL
Neither	2nd	1st	دُذْ	.21
N	2	1	دَازْ	.22
N	2	1	دُوذْ	.23
N	2	1	دَزْ	.24

			SOUND DRILL
Neither	2nd	1st	دِ .5
N	2	1	دُ .6
N	2	1	دَ .7
N	2	1	دُ .8

2nd	1st		
		PRESENTATION	
دا	دَ	.25	
دو	دُ	.26	
دي	دِ	.27	
دِ	دي	.28	
	ي	.W	
		GRAPHIC DRILL	

3rd	2nd	1st		
			PRESENTATION	
دَدَ	دَذْ	دَ	.9	
دُدُ	دُزْ	دُ	.10	
دِدِ	دِذْ	دِ	.11	
دِزْ	دَذْ	دَزْ	.12	
c	c	c	.W	
			GRAPHIC DRILL	

				SOUND DRILL
N	2	1	دِ	.29
N	2	1	دو	.30
N	2	1	دي	.31
N	2	1	دا	.32

END OF GRAFDRIL No. I

				SOUND DRILL
N	2	1	دُذْ	.13
N	2	1	دَزَ	.14
N	2	1	دِذْ	.15
N	2	1	دَزْ	.16

To 17 AT TOP CENTER

Tapescript for Arabic Grafdril No. I

Arabic Grafdrils, a programmed aid for learning the Arabic writing system. The English voice is Graham Leonard, the Arabic voice, "Sami Atallah."

GRAFDRIL No. I. Look at item (1) near the upper right hand corner of the page. Listen to the Arabic speaker as he reads the three printed short syllables in item (1) from right to left: first, "da"; second, "du"; third, "di." The consonant in each of the three is the same and is roughly equivalent to an English d. The short diagonal stroke above the first consonant is the short vowel mark pronounced "'a"; therefore the first short syllable is read, "da." The small curved stroke resembling a comma written above the second consonant is the short vowel mark pronounced "'u." Together, they are read, "du." The short diagonal mark below the third consonant is pronounced "'i." The third short syllable is read "di."

In items (1) through (4), look carefully at each syllable as it is read by the Arabic speaker and mimic the syllable aloud immediately. Then you will hear it repeated after you. Item (1), first syllable, look, listen, mi ic and listen, "da"---"da." Second syllable, look, listen, mimic and listen, "du"---"du." Third syllable in item (1), look, listen, mimic and listen, "di"---"di." Look at item (2). (Even numbers are in handwriting while the odd are printed.) For each syllable, look, listen, mimic and listen; first, "du"---"du"; second, "di"---"di"; third, "da"---"da." Item (3), the same: first, "di"---"di"; second, "du"---"du"; third, "da'---"da." Item (4), the same, "du"---"du"; second, "da"---"da"; the third "di"---"di."

In the Writing Drills, the arrows indicate the directions of strokes in writing. The consonant is written before the short vowel. With your pencil, trace the dotted lines to write "da"---. Now, below the "da" you have just traced, write "da" yourself in the same way you traced it and in the same directions the arrows indicated. Look carefully at the second syllable and the arrow of direction. Now trace "di" over the dotted lines.--- Below it write "di"---. Observe the third syllable in the Writing Drill. Trace the dotted lines to form "du"---. Below it, write "du"---.

Now return to item (1). This time for items (1) through (4), you will hear just one Arabic syllable read from each item. Listen carefully and mark under the written form of the syllable which you hear read. Item (1) "da,"---. Was that the first, or second, or third? Mark under the written syllable you think it was.--- You should have marked under the first, which was read "da." If you did not mark under the correct syllable before the answer was given, or if you marked the wrong syllable, circle the correct one. Do the same in all test drills in the Grafdrils. Now listen to one syllable from item (2) and mark under it: "di,"---. That was the second written syllable, "di,"---. In item (3) do the same: "du,"---. You should have marked the second, "du"---. Listen and mark also in item (4), "di,"---. That was the third, "di"---.

In items (5) through (8), we will follow a different procedure. After each item, you will see one Arabic syllable written. Look at it carefully and read it to yourself.--- Then you will hear two syllables spoken. You will mark whether the written syllable is the first, or the second, or neither of the syllables spoken. Item (5), look carefully at the printed Arabic syllable.--- Now follow the spaces as two syllables are spoken and mark whether the first, second, or neither is the printed syllable "di"---"da"---. You should have marked the first space, "di"---. Item (6), look at the written syllable.--- Follow the spaces and mark as two syllables are spoken "da"---"di"---. You should have marked under N as neither syllable spoken was the one written. The syllable written in item (6) is read, "du"---. Item (7), read---, listen carefully to two syllables and then mark: "du,"---"da"---. The second "da"---. Look at item (8), ---. Now listen and mark: "du"--- "di,"---. The first, "du."

In item (9), the second and third each have two consonants. The third is two short syllables. The second is a closed syllable as there is a small circle, called a "sukuun" over the second consonant indicating no vowel follows the consonant. It's name is "sukuun." Now follow carefully the Arabic printing and writing in items (9) through (12), and listen, mimic aloud, and listen again. Item (9), first, "da"---, "da"; second, "dad"---, "dad"; third, "dada"---, "dada." Item (10), first, "du"---,"du"; second, "dud"---, "dud"; third, "dudu"---, "dudu." Item (11), first, "di"---, "di"; second, "did"---, "did"; third, "didi"---, "didi." Item (12), first, "dad"---, "dad"; second, "dud"---, "dud"; third, "did"---, "did"---. In the Writing Drill, look at the

"sukuun" above a C (for consonant). Trace over the dotted "sukuun" above the second C. You write a "sukuun" above the third C.--- Go back to (9). For items (9) through (12), you will hear the first or second or third read in Arabic. Listen carefully to what is read in each item and underline its written form. Item (9). Which of the three is this? "da"---. The third, "dada." (Circle the correct one if you were wrong.) Item (10). Underline this. "dud"---. The second, "dud." Item (11). Which is this? "didi"---. The third, "didi."--- Item (12). Mark this. "dad"---. First, "dad."---

In items (13) through (16), look carefully at the printed or written Arabic. You will hear two units of Arabic spoken in each item. Mark whether the Arabic you see is the first, second, or neither of the units spoken. Item (13). Look at the Arabic.--- Listen to two units of Arabic spoken and mark "dud"---"dud"---. The second you heard is correct: "dud"---. Item (14). Look at what is written. --- Listen and mark: "dad"---, "da"---. Neither was what is written. It is "dada"---. Item (15). Read. --- Listen to two units of Arabic spoken and mark: "did"--- "didi"---. The first, "did"---. Item (16). Look---, listen, and mark: "dada"---, "dad"---. The second, "dad." ---

At top left center, item (17). Listen as the two units of Arabic are read, noting especially the length of the vowel sounds. First, "dad" ---, second, "daad" ---. The vertical mark after the first consonant in the second unit of Arabic indicates the long vowel sound "'aa"---. (The short vowel mark "'a" may be omitted or written on the preceding consonant.) Listen as the two closed syllables in item (17) are read again and mimic aloud after the first reading of each by the Arabic reader. "dad" ---, "dad"; "daad" ---, "daad" ---. In item (18), listen as the two closed syllables are read. First, "dud" ---; second, "duud" ---. The mark resembling a large comma after the first consonant in the second syllable indicates the long vowel sound "'uu" ---. (The short vowel mark "'u" may be omitted. Listen as the two closed syllables in item (18) are read again and mimic aloud after the first reading of each. "dud" ---, "dud"; "duud" ---, "duud." Mimic aloud after the first reading in items (19) and (20), and listen as the Arabic speaker repeats it after you have mimicked. Item (19). First, "duud" ---, "duud"; second. "dud" ----, "dud" ---. (20). First. "daad" ---, "daad"; second, "dad" ---, "dad" ---. (in hand-written Arabic, the long "'aa" need not extend down as far as its printed form. See item (17).)

In the Writing Drill, note the directions of the writing. Trace the long vowel "'aa" under 2 ---. Write "'aa" under 3 ---. Trace over the dotted lines of the long vowel "'uu" ---. Now write "'uu" to the left under 3 ---. Returning to items (17) through (20), mark under the closed syllable you hear read in each item. Item (17). Underline "dad" ---. That was the first, "dad," not the second, "daad" ---. (Circle the correct item if you did not underline it before being told.) Item (18). Which is this? "duud" ---. The second, "duud," not the first, "dud" ---. Item (19). Underline "dud" ---. The second, "dud" ---. Item (20). Mark "daad" ---. The first, "daad" ---.

In items (21) through (24), look carefully at the one written (or printed) syllable. Mark whether it is the first, or the second, or neither of the syllables spoken. Item (21). Read ---. Listen to two syllables and mark: "duud" ---, "dud" ---. The second, "dud" ---. Item (22). Look carefully ---, listen, and mark: "dad" ---, "duud" ---. Neither syllable was correct. The written syllable is read "daad" ---. Item (23). Look at the Arabic, --- listen to two syllables, and mark: "dud" ---, "duud" ---. The second, "duud" ---. Item (24). Read ---; listen, and mark: "dad" ---, "daad" ---. The first, "dad" ---.

In Items (25) through (28), mimic each syllable after the Arabic reader and listen to (25): first, "da" ---, "da"; second, "daa" ---, "daa" ---. Item (26). First, "du" ---, "du" ---; second, "duu" ---, "duu" ---. (27): first, "di" ---, "di"; second, "dii" ---, "dii". The looped form with two dots under it following the consonant in the second syllable of item (27) indicates the long vowel sound "'ii". (The short vowel mark "'i" may be omitted or written under the preceding consonant.) Item (28). First, "dii" ---, "dii"; second, "di" ---, "di" ---.

In the Writing Drill note that the two dots under the long vowel "'ii" may be written as a short horizontal line in handwriting. Note the directions of the strokes. The body of the letter is written before the dots or line under it. Trace the long vowel "'ii" over the dotted lines ---. Then write long vowel "'ii" to the left ---. Return to items (25) through (28) underlining the syllable you hear read in each. Item (25). Which is this? "daa" ---. The second, "daa" ---. (Circle the correct answer if you had not underlined it.) (26): underline "du" ---. The first, "du" ---. Item (27). Which is this? "dii" ---. The second, "dii", not the first, "di" ---. Item (28). Underline this "di" ---. Also the second: "di," not the

first "dii."

In items (29) through (32), look carefully at the one printed or written syllable. You will hear two syllables spoken. Mark whether it is the first or the second or neither of the syllables spoken. Item (29). Read --- . Listen to two syllables and mark the appropriate space. "dii"---, "di". The second, "di" ---. (Circle the correct answer if you had not underlined it.) (30): read ---; listen; and mark: "duud" ---, "du" ---. Neither was correct. It is instead, "duu" ---. Item (31). Read ---; listen; and mark: "dii" ---, "di" ---. The first, "dii" ---. Item (32). Read ---; listen; and mark: "daad" ---, "daa" ---. The second, "daa."

This is the end of Arabic Grafdril number I.

APPENDIX B

ARABIC GRAFDRIL No. XV

	1	2	3
	[وَ+ثَ+بَ]	[خَ+ثِ+رَ]	[ل+ا+ثَ]
1.	وَثَبَ	خَثِرَ	لاثَ
2.	ثِمارٌ	مِثْلَ	بُثَّتْ
3.	ثَقيلٍ	يَجْثو	غَيْثٌ
4.	ثُلاثِيَّةٌ	يُثَقِّفُ	بَحْثٍ
W.	ثَـ ثَـ ثَـ ثَـ ثَـ ثَـ		
W.	ثَـ ثَـ ثَـ ثَـ ثَـ ثَـ		
W.			

	1	2	3
	[عَ+يْ+نْ]	[بَ+عَ+ثَ]	[ب+ا+عَ]
17.	عَيْنٌ	بَعَثَ	باعَ
18.	عُقِدَ	جَميعاً	شُجاعٌ
19.	عَظيمٍ	صَعَّرَ	صُنِعَ
20.	عَذَّبَ	بَعْضُ	يَضيعُ
W.	غَـ صَـ خَـ ضَـ عَـ		
W.			
W.			

5.	ثَوْبٌ	1	2	N
6.	بَثَّتْ	1	2	N
7.	ثابَ	1	2	N
8.	يَغيثُ	1	2	N

9.	حَثيثٌ	حَشيشٌ	يَثوخُ	
10.	ثَمَجَ	مَثَمَجَ	تَلاثَخَ	
11.	ثَوْمٌ	لُهاثي	ثَخَنَ	
12.	ثَوْريَّةٌ	هُدِثَتْ	تَشَبَّثَ	

13.	جَثَمَ	1	2	N
14.	ثَمَّ	1	2	N
15.	يَسْتَثيرُ	1	2	N
16.	هَثَّةٌ	1	2	N

21.	زَعَفَ	1	2	N
22.	شَعَّلَ	1	2	N
23.	عَصَبٌ	1	2	N
24.	بَلَعَ	1	2	N

	1	2	3
25.	عَدَّ	حَدَّ	هَدَّ
26.	تَبوعُ	تَبوغُ	تَبوحُ
27.	يَفْعَمَ	يَفْغَمَ	عاشَ
28.	كَزَرْعٍ	ذَعَجَ	تَعوجُ

29.	شاعَ	1	2	N
30.	بَعْدَ	1	2	N
31.	عاوَنَ	1	2	N
32.	ضَغَطَ	1	2	N

Tapescript for Arabic Grafdril No. XV

"Θa" is the consonant introduced in the middle and at the end in the three brackets. Observe the initial, medial, and free forms of "Θa" in item (1). Observe the final form of "Θa" in the third word of (2). The sound of "Θa" is similar to the aspirated th at the end of English bath, or the lisping th at the beginning of the kidding expression "thay kid" of a few years back. "Θa" is characterized by three dots or a handwritten inverted v above a tooth. Mimic the words in (1) through (4) after they are read, listening in (1) for repeats:

(1) "waΘaba" --- "waΘaba"; "xaΘira" --- "xaΘira"; "laaΘa" --- "laaΘa".
(2) "Θimaarun" ---; "miΘla" ---; "buΘΘa" ---.
(3) "Θaqiilin" ---; "yajΘuu" ---; "gayΘun" ---.
(4) "ΘulaaΘiyyun" ---; "yuΘaqqifu" ---; "bahΘin" ---.

Initial "Θa" may have three dots, or a handwritten inverted v above a tooth or very short ascender or simply above the beginning of the written line. The three dots or inverted v are added after the writing sequence is completed and before the short vowel mark. Trace both forms of initial "Θi" ---. Write initial "Θu" in both variations ---. Medial "Θa" is a small tooth made by a slight retracking in the line of writing, with three dots or an inverted v added above after the sequence is completed. Trace medial "Θi" ---. Write medial "Θu" ---. Final "Θa" begins with a tooth in the line of writing and adds a shallow saucer curving upward at the end. The three dots or inverted v of final "Θa" are to the left of the tooth above the saucer. Trace final "Θi" ---. Write final "Θu". There are two variations of free "Θa". One is similar to final "Θa" without a connection free stroke. The other "Θa" is a shallow bowl. Both forms have the characteristic three dots or inverted v above the shallow saucer. Trace both variations of free "Θi" ---. Write free "Θu" in both forms ---. Return to (1) through (4) underlining the word read "Θa":

(1) "laaΘa" ---: third, "laaΘa" ---.
(2) "miΘla" ---: second, "miΘla" ---.
(3) "ǵayΘun" ---: third, "ǵayΘun" ---.
(4) "ΘulaaΘiyyun" ---: first, "ΘulaaΘiyyun" ---.

In (5) through (8), read, listen to two, and mark:

(5) ---, "Θawbun"; ---, "ðawbun" ---: first, "Θawbun".
(6) ---, "baðða ka"; ---, "baΘΘka" ---: second, "baΘΘaka".
(7) ---, "ðaaba"; ---, "taaba" ---: neither; it is "Θaaba".
(8) ---, "yaǵiiḏu"; ---, "yaǵiiΘu" ---: second, "yaǵiiΘu".

(9) through (12). Mimic each word after the Arabic speaker, listening in (9) for repeats:

(9) "ḥaΘiiΘun" ---, "ḥaΘiiΘun"; "ḥašiišun" ---, "ḥašiišun"; "yaΘuuxu" ---, "yaΘuuxu".
(10) "Θamaja" ---; "šamaja" ---; "talaaΘaǵa" ---.
(11) "Θawmun" ---; "luhaaΘii" ---; "Θaxana" ---.
(12) "Θawriyyun" ---; "hulaaΘun" ---; "tašabbaΘa" ---.

Return to (9) through (12), underlining the word read:

(9) "ḥašiišun" ---: second, "ḥašiišun" ---.
(10) "Θamaja" ---: first, "Θamaja" ---.
(11) "Θaxana" ---: third, "Θaxana" ---.
(12) "Θawriyyun" ---: first, "Θawriyyun" ---.

(13) through (16). Read, listen to two, and mark:

(13) ---, "jaΘama"; ---, "jaðama" ---: first, "jaΘama".
(14) ---, "Θamman"; ---, "ðamman" ---: first, "Θamman".
(15) ---, "yastašiiru"; ---, "yastaΘiiru" ---: second, "yastaΘiiru".
(16) ---, "ḥaḏḏun"; ---, "ḥaððun" ---: neither; it is "ḥaΘΘun".

In the brackets above (17), the consonant sounding "c" is introduced at the beginning, in the middle, and at the end. Observe the initial, medial, and free forms of "c" when connected in the three words in item (17), and listen as they are read: "ᶜaynun"; "baᶜaΘa"; "baaᶜa". Observe the final form of "c" in the third word of (19). There is no sound in English similar to "c". Mimic the words in (17) through (20) after they are read, listening in (17) for repeats:

(17) "ᶜaynun" ---, "ᶜaynun"; "baᶜaΘa" ---, "baᶜaΘa"; "baaᶜa" ---, "baaᶜa".
(18) "ᶜuqida" ---; "jamiiᶜan" ---; "šujaaᶜun" ---.
(19) "ᶜaḏiimin" ---; "saᶜᶜara" ---; "suniᶜa" ---.
(20) "ᶜaḍḍaba" ---; "baᶜḍu" ---; "yaḍiiᶜu" ---.

Initial "ᶜa" is an open counter-clockwise loop retracking along the base to join to the following letter. Trace initial "ᶜi" ---. Write initial "ᶜu" ---. Medial "ᶜa" has two variations. One medial "ᶜa" is a simple, small, flattish loop. There are variations from that to the printed form of medial "ᶜa" which is a triangular loop made clockwise from the line of writing. Trace both variations of medial "ᶜi" ---. Write both forms of medial "ᶜu" ---. Final "ᶜa" is a clock-wise loop, that may have triangular tendencies, with a descender tail curving right. Trace final "ᶜi". Write final "ᶜu" ---. The free form of "ᶜa" has an open counter-clockwise loop above a descender tail curving right. Trace free "ᶜi" ---. Write free "ᶜu" ---. Return to (17) through (20), underlining the word read:

(17) "ᶜaynun" ---: first, "ᶜaynun" ---.
(18) "jamiiᶜan" ---: second, "jamiiᶜan" ---.
(19) "ᶜaðiimin" ---: first, "ᶜaðiimin" ---.
(20) "baᶜḍuṃ" ---: second, "baᶜḍuṃ" ---.

(21) through (24). Read, listen to two, and mark:

(21) ---, "zaḥafa"; ---, "zaǵafa" ---: neither; it is "zaᶜafa".
(22) ---, "šaᶜᶜala"; ---, "šaǵǵala" ---: first, "šaᶜᶜala".
(23) ---, "ǵaḍabun"; ---, "ᶜaṣabun" ---: second, "ᶜaṣabun".
(24) ---, "balaǵa"; ---, "balaᶜa" ---: second, "balaᶜa".

(25) through (28). Mimic each word read, listening for repeats in (25):

(25) "ᶜadda" ---, "ᶜadda"; "ḥadda" ---, "ḥadda"; "hadda" ---, "hadda".
(26) "tabuuᶜu" ---; "tabuuǵu" ---; "tabuuhu" ---.
(27) "yafᶜama" ---; "yafǵama" ---; "ᶜaaša" ---.
(28) "kazarᶜin" ---; "ðaᶜaja" ---; "taᶜuuju" ---.

Return to (25) through (28), underlining the word read:

(25) "ḥadda" ---: second, "ḥadda" ---.
(26) "tabuuᶜu" ---: first, "tabuuᶜu" ---.
(27) "ᶜaaša" ---: third, "ᶜaaša" ---.
(28) "taᶜuuju" ---: third, "taᶜuuju" ---.

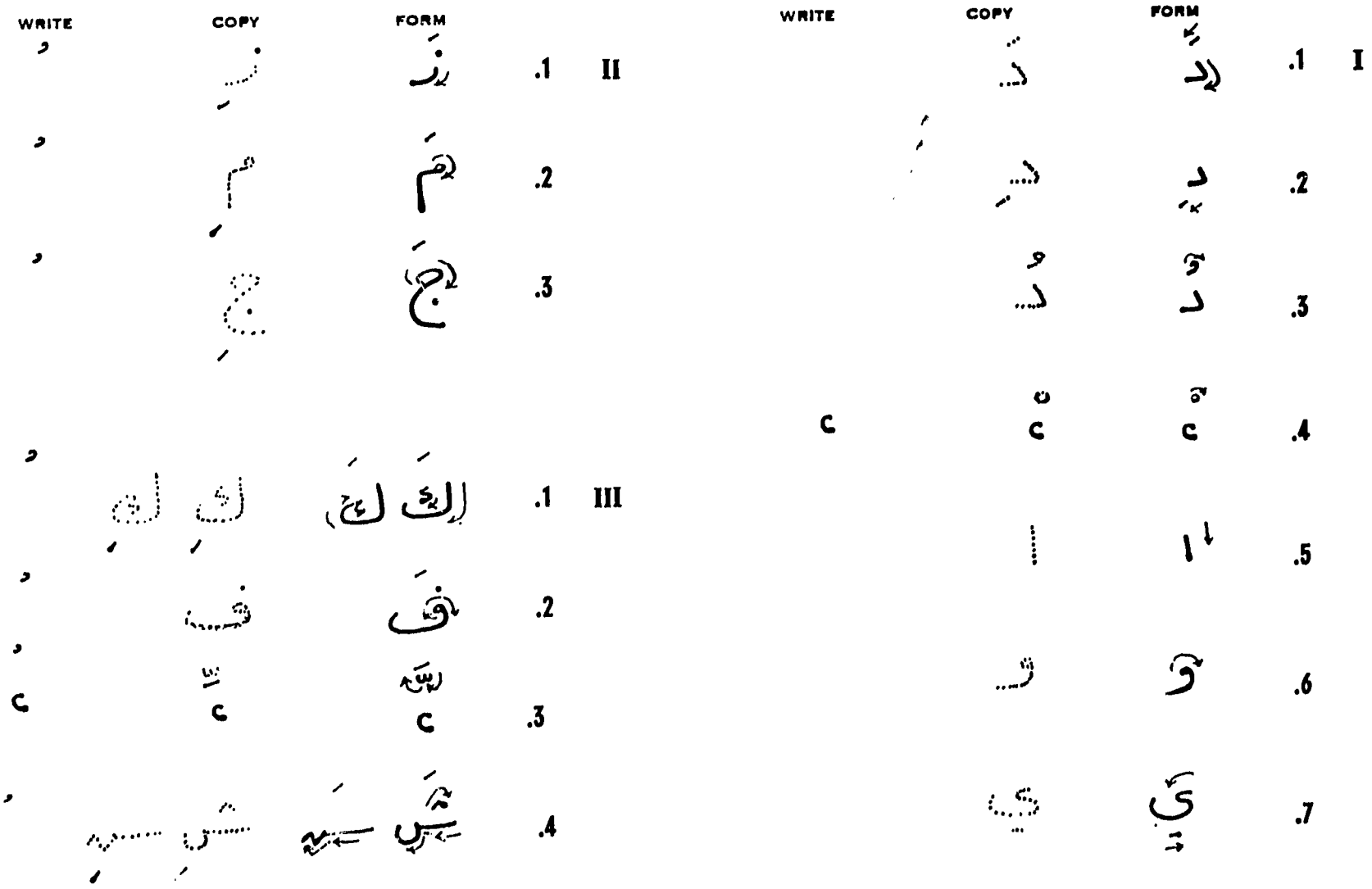
(29) through (32). Read, listen to two, and mark:

(29) ---, "šaaᶜa"; ---, šaᶜᶜa" ---: first, "šaaᶜa".
(30) ---, "baᶜuda"; ---, "baᶜda" ---: second, "baᶜda".
(31) ---, "ᶜawwana"; ---, "ᶜawna": neither; it is "ᶜaawana".
(32) ---, "ḍaǵaṭa"; ---, "ḍaᶜaṭa"---: second, "ḍaᶜaṭa".

End of Grafdril XV.

APPENDIX C

ARABIC GRAFDRILS — WRITING PRACTICE



APPENDIX D

Instructions to the Compiler of the Criterion Test

This test is to be the criterion of comparison between subjects, and between control and experimental groups and individuals of the pairs.

The Arabic Grafdrils propose to teach the Arabic Writing System. Specifically, the method attempts to teach (1) discrimination between the phonemes of Arabic, (2) recognition of the graphemes of Arabic and discrimination between them while associating the respective phonemes with their corresponding graphemes. The subjects should primarily be able to transcribe correctly from dictation simple Arabic words or Arabic type forms (upon hearing the spoken Arabic only twice, spaced five seconds apart and with fifteen seconds for writing before the next word is read). Secondarily, they should be able to write recognizable Arabic letters and words. Only incidentally as part of the learning process, were they encouraged even to attempt to reproduce the sounds of Arabic. The subjects should be able to recognize the variant forms of each letter and should know which letters connect and which do not. They should know how a ligature for "laam'alif" is made, a "maddah," "'alif-maqsuurah," etc. They should be especially able to differentiate and recognize the different vowels, the long vowels, the "šaddah" (especially contrasted to same consonant followed by long vowel "'alif"). They are <u>not</u> to be held responsible for the names of the letters, their alphabetic order, nor for any transliteration or phonemic transcription system. While they were taught the positions of the "hamzah," they cannot really be held responsible for knowing the rules of seats in dictation. Nor are they to be expected to know the rules for liaison or pausal forms or any of the variants of connected speech. They should be able to put a "šaddah" on "sun" letters when made definite by "'al." They should be especially examined on those graphemes that have similar features and on those phonemes which are not distinguished in English. (All subjects are native speakers of English by design and definition.)

Please prepare a test that will cover the above points as well as you might expect your beginning students to know the material at the end of the first twelve hours of instruction. You are not to show the test to either Mr. Bishai nor the writer lest the instruction be unconsciously keyed to the expected test. Please have the test reproduced using at least half of the writing in typewritten script (all vowelled as no meaning is to be covered at all in the entire twelve hours) and the remainder in the good handwriting of a native speaker of Arabic. Please reproduce this in as legible a form as possible--if necessary by photo-offset for which you will be reimbursed. Please prepare a tape of the required voice to go with the examination so that the test can be repeated in future experiments without deviation as to time or accent. Use the voice of a native speaker of Arabic in all Arabic words or Arabic-like forms that are included in the test. The words need not be real Arabic words though that would be desirable. The Arabic speaker should speak Standard Contemporary Arabic with as little colloquial accent as possible. Perhaps part of the test should be done by a Palestinian and part by an Egyptian as the experimental group will be hearing a Palestinian all of the time and the control group an Egyptian.

There should be ten words for dictation (allowing five seconds before the second of two readings of the word), and fifteen seconds thereafter for writing the word. The words dictated should include as many different Arabic graphemes as possible (as many different letters in as many different forms as possible). They should be words that include phonemes an English speaker may not differentiate, words that have minimal pairs for the confusing phonemes. They should be words that require knowing rules of connection and ligatures and one or two with sun or moon letters. The words should be as short as possible and should include long-short vowel contrasts and doubled consonants contrasted with long "'alif." A space should be left on the examination paper for writing the ten dictated words (which will count two points each).

There should be six words written in Arabic on the test with space provided after each so that the subjects may write all the other possible forms of the letters contained in each word to indicate that he recognizes the graphemes that make up each of the six words and that he demonstrates that he knows how to make the free form of that grapheme. You may wish to discuss this section with Mr. Bishai and the writer. Each word would count two points, or twenty points for

the section.

There should be fifteen pairs (minimal as to graphemic differences) of Arabic words on the test sheet. One of the two should be read with five seconds allowed in which to underline the word which was read (only once). These words should include the most difficult or obvious possible confusions as to the graphemic features which are minimal in difference. Each word would count two points or total of thirty.

There should be fifteen numbers after each of which is written one Arabic word, followed by numerals one and two and the word "neither." Two words should be read on the tape with only a second between them and about five seconds after the two in which the subject should underline whether the first, second, or neither of the words read is the one written after that number. Some time should be left at the beginning of each number for the subjects to read the word written, to themselves, to prepare to hear the two read. At least two (preferably three) of the items should have two other words read that contrast minimally phonemically to the word written so that they should underline "neither." The other items should be minimal pairs, including the written word at random first or second, contrasting phonemic features that an English speaker would especially be expected to have difficulty with (including long and short vowel contrast and "šaddah" contrasted to long vowel "'alif" after the consonant). This section would count thirty points or two points for each item.

The test should take about twenty minutes and not more than thirty. If it is seen that the test would take longer, the number of items should be reduced in number and more care taken to choose as many contrasting features as possible. In grading the dictation, writing should be counted correct if recognizable as the grapheme intended, with a maximum of tolerance.

Enclosed is a copy of Rice's The Classical Arabic Writing System (1959), and a copy of the printed materials of Arabic Grafdril in its third revision which is being used, and in the second edition which is not being used. Mr. Bishai has been asked to provide you with copies of the written materials he plans to use in order to give you an idea of what has been covered to make the test as fair as possible.

Attached, also, is a blank copy of the script of the test (without the Arabic words which you will add). In summary, the following are required:

10 Arabic words for dictation. (Each word will be spoken only twice.)
15 sets of minimal pairs. (One of each pair to be read only once.)
15 written words (with two words to be read aloud for each, either the written word and a minimal pair or two words contrasting with the written word minimally).
6 written words containing as many different letters as possible.

Include contrasts of long to short vowels, nunation to short vowels, sun letter with the definite article contrasted to the same sun letter without the definite article, "ḍaad" to "daal," etc. (sound contrasts), "daal" to "taa'" to "ðaal" to "zaa'," etc. (sound plus visual contrasts), "šaddah" to long vowel (i.e. "najjara" to "najaara"), "daal" to "laam" to "'alif," etc. (visual contrast only), "waaw" and "yaa'" as vowels to "waaw" and "yaa'" as consonants, diphthong to harmony (also with "šaddah"), "hamzah" to "ᶜayn" to long "'alif."

APPENDIX E

INSTRUCTION SHEET FOR TEST ON ARABIC SOUNDS AND WRITING SYSTEM

In this test, time is important. Relax, but move from item to item with the recorded instructions. Do not worry about previous items and do not try to go back. If you are not sure, guess and go on.

Part I of this has fifteen items. In each item, one of the two written Arabic words will be read aloud (one time only). You are to underline the written form of the one word you hear. You will have five seconds after each word is read.

Part II has one written word in each item from 16 through 30. Read each to yourself. You will then hear two Arabic words spoken. You are to underline whether the written word is the 1st, or the 2nd, or neither (N) of the words spoken.

Part III. In spaces 31 through 40 on this paper, write the ten words dictated (each word will be repeated once after five seconds with time for adding to or changing what you have written). Include all short vowels and other Arabic marks. Write the best you are able. You can judge time by the first item.

.36	.31
.37	.32
.38	.33
.39	.34
.40	.35

Part IV on test sheet. After each of the six words from 41 to 46, write the free or unconnected form of each letter in the word. Examples:

ex: مُحَمَّدٌ = مُ + حَ + مْ + مَ + دٌ

ex: فَعَلَ = فَ + عَ + لَ

Appendix E, continued

NAME---------- TEST FOR ARABIC WRITING SYSTEM AND ARABIC SOUNDS

Underline the one word read. -I

.1 خَيْرَ حَبْرَ

.2 عَيْبٌ غَيْبٌ

.3 قُولُ فُولُ

.4 ثَلْجٌ بَلْخٌ

.5 شَجٌ شَيَحُ

.6 جِوارٌ جِوازٌ

.7 رَفيعَه رَقيعَه

.8 نَقَدَ فَقَدَ

.9 سِراحٍ سِراجٍ

.10 قُبِلَ قُتِلَ

.11 الدَّيْنَ الذَّيْنَ

.12 بَيْتٌ بِنْتٌ

.13 الكِتابَ الكِتّابَ

.14 الأَدَبِ الأَرَبِ

.15 حَظٌّ خَطٌّ

Underline 1st, 2nd, Neither. -II

.16 حامِضٌ N 2nd 1st

.17 واضَحَ N 2nd 1st

.18 هُروبٍ N 2nd 1st

.19 النَّهّارُ N 2nd 1st

.20 ظاهِرٍ N 2nd 1st

.21 فَظَّ N 2nd 1st

.22 ماذا N 2nd 1st

.23 راقِدٌ N 2nd 1st

.24 حَسَنَهْ N 2nd 1st

.25 عَزيزٍ N 2nd 1st

.26 عامَ N 2nd 1st

.27 عالِمٌ N 2nd 1st

.28 شَوْطٌ N 2nd 1st

.29 شَكَّ N 2nd 1st

..30 رَأى N 2nd 1st

Arabic dictation of ten words to be written on separate instruction sheet (31-40). -III

Write the free (unconnected) form of each letter in the following six Arabic words. -IV

.41 أَبُو

.42 هِنْدٌ

.43 مَلِكٌ

.44 حَريصَ

.45 سَطْحٌ

.46 الأُفُقَ

APPENDIX F

Test for Arabic Writing System and Arabic Sounds

(Tapescript)

Part I. In (1) through (15), you see two Arabic words written. One of the two words will be read aloud one time and one time only after the number is read in English. You will then be given about five seconds to underline the correct form of the word which was read. Look only at your own paper and do not worry or look back at what is finished.

Item	(1)	Underline	xabra	(9)	siraajin
	(2)		ğaybun	(10)	qutila
	(3)		quwlu	(11)	allaẍayna
	(4)		balxin	(12)	baytun
	(5)		šayahu	(13)	alkittaaba
	(6)		jiwaazun	(14)	al'arabi
	(7)		rafiiqa	(15)	haẍẍou
	(8)		naqada		

Part II. (Roman numeral two at the left side of the middle of the page at top). In (16) through (30), you see one Arabic word written in each item. Read the word silently to yourself. You will then hear two Arabic words spoken (read only once). You will then mark whether the written word is the first, second, or neither of the words spoken. Underline first, second, or N (for neither).

Item	(16)	Look at the written word. Listen to two words and underline.	xaamidun	--	ḥaamidun
	(17)	Listen to two and mark.	waaḍaᶜa	--	waadaᶜa
	(18)	Listen to two and mark.	ḥuruubin	--	huruubin
	(19)	Listen to two and mark.	ḍal'azharu	--	al'azhaaru
	(20)	Listen to two and mark.	ẍaahirin	--	zaahirin
	(21)	Listen to two and mark.	faẍẍa	--	faẍẍa
	(22)	Listen to two and mark.	maḍaa	--	maaẍaa
	(23)	Listen to two and mark.	raaqidun	--	raakiḍun
	(24)	Listen to two and mark.	ḥasan	--	ḥasaan
	(25)	Listen to two and mark.	ᶜaziizin	--	'aziizin
	(26)	Listen to two and mark.	ᶜamma	--	ᶜaamma
	(27)	Listen to two and mark.	ᶜaalamun	--	ᶜaalimun
	(28)	Listen to two and mark.	sawṭun	--	sawtun
	(29)	Listen to two and mark.	šakka	--	šaqqa
	(30)	Listen to two and mark.	raᶜaa	--	ra'aa

Part III. Turn to your instruction sheet and find Roman Numeral three with numbers (31) through (40). Ten Arabic words will be read to you, one after each number. You are to listen carefully to the Arabic word and write it after the number indicated. After five seconds, the same word will be read again. You will then be given time to correct the word you have written. Be sure to include all vowel and other marks. There will be enough time.

		(count eight)		(count twenty)
Item (31) --	qawmu	--------	qawmu	----------
(32) --	ǧaybun	--------	ǧaybun	----------
(33) --	zaara	--------	zaara	----------
(34) --	fiila	--------	fiila	----------
(35) --	halaaku	--------	halaaku	----------
(36) --	jaḥ̣ši	--------	jaḥ̣ši	----------
(37) --	duuna	--------	duuna	----------
(38) --	taʿaamu	--------	taʿaamu	----------
(39) --	ẋaatun	--------	ẋaatun	----------
(40) --	θumma	--------	θumma	----------

Now turn your instruction sheet face down. Return to Part IV (Roman Numeral four) on the test sheet. In (41) through (46), there are six Arabic words. After each word, write the free (unconnected) form of each letter in that word. You will have exactly six minutes. Sit quietly when you have finished and do not write on any other part of the test. Part four, begin. (Leave exactly six minutes on tape.)

Stop. Put your pencils or pens down. Turn in your papers immediately. Thank you very much. Maʿa-ssalaamah.